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WEST AFRICAN AGRICULTURE.

IT will be recalled that in 1926 Mr. Ormsby-Gore presented a valuable report on his tour of the British West African possessions. Although this dealt with many aspects of the West African question, a number of important points regarding the agricultural development of these Colonies were discussed. It was stated, at the time, that little had been done with regard to the improvement of native methods of cultivation, that many of the raw agricultural materials were being produced in a wasteful manner and that there were serious dangers with regard to the continuance of the existing methods of "shifting cultivation." Information was lacking also with regard to the numerous problems connected with the cultivation and manuring of certain staple crops, while it was felt that little attention had been paid to the question of animal husbandry. The adequate supply of local foodstuffs to replace foods imported for native consumption had been neglected. Mr. Ormsby-Gore was also of the opinion that the development of our tropical possessions depended on the realisation of the value of a scientific staff, both for the laboratory and the field, and thought that careers should be provided in the agricultural departments in the Colonies which would attract "personnel not only of high technical qualifications but of capacity for leadership and ability to inspire others." From Mr. Stockdale's report * on his recent visit to these Colonies it appears that Mr. Ormsby-Gore's remarks have had some influence in stimulating a number of changes in the general agricultural policy of this part of the British Empire.

Mr. Stockdale, who is the Agricultural Adviser to the Secretary of State for the Colonies, went to the Gold Coast in October last to attend the Second West African Conference. He was subsequently instructed to visit Nigeria, Sierra Leone and the Gambia, and he has thus been given exceptional opportunities of getting into touch with a large number of agricultural officers in service and of forming an opinion of their activities. His report is a brief commentary of the work of the Conference and of the Agricultural Departments which he inspected.

The Conference's main work was apportioned to several Sub-Committees which were appointed to deal with specific questions and subjects. Matters which received full consideration by the Conference as a whole were the West African cocoa

and palm oil industries, the Colonial Agricultural Service, Imperial Agricultural Bureaux, work in economic botany for the Colonies at Kew, field experimentation, inspection and certification of produce, the organisation of special research for oil palms in West Africa, possible measures to prevent the introduction of witch broom disease of cocoa in West Africa and suggestions for the next Imperial Agricultural Research Conference in Australia in 1932.

The formation of a Unified Agricultural Service was generally recognised as being essential to progress but it was realised that its organisation offered considerable administrative difficulties. The need for flexibility in this scheme was advocated. The division of the Service into agricultural and specialist wings was believed to be a mistake: agricultural officers might become "specialists in the agronomy of tropical crops, rural economics . . ." and "under Colonial conditions specialization amongst field officers was equally important as specialization amongst laboratory workers." This is a point of view which will be shared by many of those already in the Service and it is satisfactory to note that it was so fully appreciated by the Conference. Discussion also centered on the question of the interchange of officers and on the steps to be taken for the foundation of a professional Association of agricultural officers throughout the Empire.

Special researches into cocoa and palm oil were given very careful consideration. It was generally felt that the Gold Coast should stand the brunt of cocoa investigations and that Nigeria and Sierra Leone should concentrate on the palm oil crops. The Conference rejected, for the present at least, the proposal that there should be a central West African Station for palm oil research, as the economic conditions governing the oil palm industries indicated that local work was the first essential. Problems in connection with these industries will, accordingly have to be attacked from different angles. Recognising the very great importance of the inspection and certification of all produce grown in West Africa, where schemes have been evolved which have already brought considerable improvements in the quality of exported produce, the Conference passed resolutions with a view to (i) securing a revision of existing standards and a clearer definition of accepted market standards. (ii) effecting, as early as possible, the unification of quality grades for export produce from British West Africa, and (iii) securing price quotations in accordance with quality through the co-operation of the Departments of Agriculture and of the merchants.

Mr. Stockdale has many interesting things to say about the activities of the Departments of Agriculture which he inspected. The Gold Coast Department has been completely reorganised into eleven subject branches, whereas in the past it consisted of a research branch and an agricultural branch. With the newly formed organisation it is expected that more investigational work on which to base extension and propaganda work will be carried out, and that the scientific worker will be brought into closer touch with agricultural practices and problems of the Colony. Amongst the most urgent of these, the following are mentioned: the improvement of cultural operations in cocoa farms; the further study of the Sahlbergella pest of cocoa and the possibility of effecting its control by agricultural means and by finding cocoa strains resistant to its attacks; an economic investigation of foodstuffs with a view to extending the cultivation of additional varieties, particularly of pulses; a solution to the problem of drying copra under the humid conditions of the Colony and a study of the farmer's cultural methods by officers of experiment stations with a view to the development of extension work from such stations. The Director has laid very great stress also on the investigation of economic problems, paying particular attention to the development of co-operative marketing societies which have been organised for the sale of the members' crops of cocoa and of which a large number are under his close supervision.

In Nigeria the field experiments of the Moor Plantation at Ibadan have been "most carefully and scientifically designed and remarkably close co-operation exists between specialists and agricultural officers." A thorough study has been made of "shifting cultivation," costings having been kept throughout the experimental work. Experiment stations in Nigeria were started with a careful study of the existing methods of cultivation and each station has definite problems to solve, and although their problems differ, the methods of attack have been designed on the model which has been found so successful at the Central Station at Ibadan. The state of general agriculture appeared to be more generally advanced than in the other West African Colonies. The agricultural problems in Sierra Leone are amongst some of the most difficult in West Africa and will require very careful study before material progress can be made, while agricultural development in the Gambia is said to be bound up with the question of man power.

It is very encouraging to find that so many steps are being taken to make full use of West Africa's vast natural resources and to see that some attention is also being paid to consolidate the positions already gained by its chief agricultural industries. The rapid developments that are taking place there are being watched with great interest by the West Indies and although the problems confronting the two groups of Colonies differ in many ways they have much to learn from each other. For this reason it might be opportune to suggest that arrangements should be made to facilitate the interchange of information. It is only by such co-operation and the dissemination of knowledge that progress can be achieved and that Colonial agricultural prosperity can be safely assured.

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*Colonial Advisory Council of Agriculture and Animal Health. C.A.C. 19. Report by Mr. F. A. Stockdale on his visit to West Africa, 1929.

BANANA FRUIT DISEASES.

A Review of the Literature on Fungal Diseases of Banana Fruits.

By C. W. Wardlaw.

[*This brief review of the literature on fungal diseases of banana fruits is preliminary to work on this subject which is being carried out at the Low Temperature Research Station of the Imperial College of Tropical Agriculture, Trinidad.*]

1. Introduction.

The literature on this subject is relatively inextensive. A number of fungal organisms are involved some of which have a wide geographical range. Significant parasitism may take place in the field or disease may only make its appearance on fruit during storage or transport. In this brief review an attempt has been made to give an account of the principal fungi involved in producing diseases of banana fruit, to indicate the salient features of their attacks, and where information is available, the conditions under which they reach their maximum importance.

The organisms which have been reported in relation to fruit-stem and finger disease include,

1. *Gloeosporium musarum*, Cooke and Massee.
2. *Cercospora musarum*, Ashby.
3. *Macrophoma musae*, Cke, Berl. and Vogl.
4. *Verticillium Sp.*
5. *Thielaviopsis paradoxa*, Von Hohnel.
6. *Fusarium Spp.*

2. Stem End Rot.

Before proceeding to an account of the individual fungi which have been investigated in detail, some reference must first of all be made to the general storage disease known as "Stem End Rot." Simmonds' account [22] is characteristic and may be quoted at length.

"This disease is sometimes known as Black End owing to the fact that affected fruit exhibit a black area of soft rot round the stem end.

"*Symptoms.*—The trouble usually commences as a dark water-soaked area formed in connection with a bruise or other injury to the short fruit stalk or working in from its broken end. As the rot progresses the stalk turns completely black and becomes much shrunken and sometimes shredded. From the stalk the soft blackened area extends through the skin of the fruit at a more or less rapid rate, the pulp beneath turning soft and watery.

"Stem End Rot is not a disease of the plantation as it usually appears only when the fruit are approaching maturity, especially after long distance consignment.

"*Cause.*—Associated with this rot are usually to be found fungi of the genera *Verticillium*, *Gloeosporium* and *Fusarium*. It would appear that under suitable conditions any weak wound parasite of this type would be capable of producing similar injury. Careful examination of affected fruit will reveal the fact that the primary cause of the trouble lies in injuries given to the fruit during the frequent handling to which it is subject. The injury may be due to bending the fruit stalks while the hand is still on the bunch. The bruise resulting from this is sufficient to constitute a point of entry for the rot-producing fungi without a definite abrasion of the skin. The wounds and bruises arising from tearing apart the fingers from the hand will also serve as infection points. These latter are a common source of trouble in cased fruit.

"*Control.*—(1) As regards fruit marketed in the bunch it is essential that the bunches receive most careful handling from the time they are cut until they reach the consumer. When one considers the rough treatment the fruit is often subjected to it is remarkable that not more damage results.

(2) In order to lessen Stem End Rot in cased fruit it will be necessary to pack in hands or half-hands rather than in singles. The hands should be carefully cut off round the collar by which they are attached to the central stalk, and if it is necessary to reduce them in size the division should be made by a sharp knife and not by a tearing process.

(3) The grower should avoid accumulating a heap of rotting banana refuse round his packing shed. This material serves as a breeding ground for the various organisms causing Stem End Rot and spores produced here may serve to contaminate fruit during the process of packing. The discarded fruit and stalks could be thrown into a pit and covered now and then with a layer of soil.

(4) The same need for cleanliness may be stressed with regard to some ripening rooms. The absence of a regular cleansing programme will increase the chance of infection with rot fungi."

It should be stated here that the term Stem End Rot leads to confusion as different diseases are implied by different workers. Thus while Simmonds uses it to denote a disease of the finger stem, the same name is also used to indicate an important downward rotting of the main stem of the whole bunch in the case of fruit transported for the English Market.

3. Gloeosporium Musarum. Cook and Massee.

This fungus, found in all parts of the world where bananas are grown, causes a fruit disease known as Banana Anthracnose, black rot, or ripe fruit rot. Fruit may be affected in the field, in the local markets or during large scale transport. The most important researches are those of Agati [1, 2] in the Philippines, and Toro [23] in Porto Rico.

Nature of the disease.

(*a*) In the field.—The most active form of anthracnose appears to be that described by Agati in the Philippines where the fungus behaves as a parasite on green fruit in the field as well as on mature fruit in storage. There, as many as 16 per cent. of the bunches may be affected.

Early stages of infection are recognised by the appearance of small black circular specks on the flowers, skin, and distal ends of the hands. These spots increase in size and as the disease reaches an advanced stage they become sunken and coalesce forming larger spots. When infection is severe the whole fruit is entirely covered with such dark blemishes. On the surface of the latter characteristic bright salmon-coloured groups of moist spores appear. Infected fruits ripen prematurely and finally turn black and rotten.

(*b*) In storage.—While in some countries *G. musarum* can definitely behave as a parasite in the field, most of the published work refers to its activity on fruit which has been reaped and stored. Thus in Toro's account the damage caused by the fungus is restricted to reaped fruit which was being used for local markets or for export. Toro states that the first manifestations of the disease appear with the ripening of the the fruit after cutting. His general description is in agreement with that of Agati, except that different degrees of infection are shown by different varieties. The final result consists in a blackening of the stem and skin, and the appearance of bright-coloured moist spore masses, while the flesh within is softened, bitter to taste and finally rotted.

Conditions of Infection.

The factors which make for significant infection by *G. musarum* include (i) atmospheric humidity and temperature (ii) presence of bruises or injuries (iii) state of maturity of the fruit and (iv) resistance or susceptibility of the banana variety under observation. Agati showed by the use of spore traps that the spores of *G. musarum* are abundantly dispersed by wind. They may also be carried by the numerous insects which frequent banana fruits. The spores germinate freely in water but are quickly affected by drought. The state of atmospheric humidity is thus of fundamental importance in determining the extent of infection. Agati found that his experimental inoculations developed most rapidly during rainy days and also that under these conditions field infections were most prevalent. He also found that fruit stored in damp places was easily affected especially when bruised in any way. The amount of disease on stored fruit was directly correlated with the degree of maturity, notably where the sweeter varieties were involved, and where fruit had been bruised in handling. On this subject it has been stated by Delacroix [10] and others that *G. musarum* is a wound parasite and that it can only cause anthracnose when fruits have been injured, Toro's inoculation experiments showed that the fungus cannot enter uninjured green or partly matured fruit in the field even of the most susceptible varieties. On the other hand completely matured bananas, when placed under proper conditions became diseased whether injured or not. This observation has been correlated with important changes in the chemical and physical constitution of the peel. These include an increase in the sugar content accompanied by a softening of tissue. Toro also demonstrated that the mycelium of *G. musarum* secretes an enzyme which though capable of dissolving the parenchymatous tissue of mature fruit, has no apparent effect on unripened bananas or on the epidermal tissue of either immature or mature fruit. He postulates mechanical injury accompanied by softening of the peel and increase in sugar content as being important conditions for infection.

Varietal Susceptibility.

Agati found that 30 different varieties under observation all showed some degree of infection by *G. musarum*. The greatest amount was found in the sweet varieties including the Lacatan, Bongolan and Cavendish. The less sweet fruits were not so subject to attack. He divided his fruits into two classes (1) those readily infected and (2) those less readily infected. The former required six to ten days for infection, the latter 15 to 23 days. All varieties, however, finally showed that some fungal penetration had taken place. Toro confirms Agati's observation that the sweeter varieties are more susceptible and quotes the Dwarf or Canary banana (*M. cavendishii*) as being the most susceptible. Plantain varieties (*Musa paradisiaca*) showed a greater degree of resistance. Toro attempted to link up the question of resistance with the tannin content of the peel. His observations, however, gave a negative result, from which he concludes that resistance and susceptibility are correlated with anatomical characters.

Strains of the organism.

From the accounts given by Agati [1], [2], Toro [23] and others it is evident that *G. musarum* exists as a number of different strains with a wide range in relative pathogenicity. On the other hand the difference in power of infection may be referable to some extent to different climatic and growth conditions, but further work is required before a definite conclusion can be given. Laubert [14] has stated that anthracnose is prevalent in consignments of bananas supplied to the German market from Jamaica and elsewhere. In 1910 he expressed the view that the causal organism was a distinct biological form and proposed the name *G. musarum* var *importatum*; subsequently it has been suggested that the organism in question is identical with or very closely related to *G. fructigenum, f. Americana.*

Preventive Measures.

The general treatment for anthracnose is similar to that prescribed by Simmonds [22] for Stem End Rot. Agati's recommendations, based on the physiological behaviour of the parasite, include the following:—Storage fruit should be kept in well ventilated rooms; fruit should be carefully handled at the time of reaping to avoid bruising; bruised fruit should never be stored with sound fruit; fruit stems should be cut with a sharp implement, and not too close to the fruit; store-rooms should be thoroughly cleaned

before storing the fruit; fruit that is attacked first should be immediately separated from sound fruit to check the further spread of the disease; spraying diseased fruit with Burgundy mixture is beneficial; since immature fruit takes a longer time to ripen and hence may be attacked by the fungus before it is ripe, fruit should never be harvested until it is mature. While Agati's recommendations may be found applicable to small quantities of fruit not all of these precautionary measures can be utilised where large consignments are being handled. Toro on the other hand states that no preventive measures can be practised advantageously, except the aeration of the "hands" in the bunches to allow of ventilation, reduce moisture and insure proper temperature.

4. Cercospora musarum, Ashby.

This organism, originally described by Ashby [4] as the fungus of "blackspot disease" on the leaves of the Gros Michel banana, has recently been shown by Ogilvie [16] to be the cause of an important disease of the Dwarf, Canary, or Cavendish banana (*Musa cavendishii*) in Bermuda known as "Black Tip." While *Cercospora musarum* has been described in relation to leaf spotting of bananas in Jamaica by Ashby, in Fiji by Campbell [6], [7], and by Dickson [11] and Simmonds [22] in Queensland, Ogilvie's work appears to be the only reference to it in a definite fruit rotting capacity. Ashby also mentions that young fruit may be badly spotted, but no rotting ensues. This organism may also be found to be the cause of a Finger tip rot described from Jamaica [3].

Occurrence and Symptoms.

Under certain conditions a black discolouration becomes apparent just below the flower and progresses down the fruit, so that in three weeks time two inches may have become affected. Diseased areas are frequently irregular in outline, they are bordered by a narrow grey or light yellow margin and frequently affect one side of the fruit more strongly than the other. The activity of the causal organism, *C. musarum*, was frequently obscured by the presence of other fungi, including species of *Fusarium*, *Aspergillus luchuensis*, *Gloeosporium musarum*, and species of *Macrosporium*, *Alternaria* and *Cephalosporium*. Various insects were also frequently found in association with diseased fruit. Inoculation experiments, both on bunches in the field and on detached fruit in the laboratory, indicated conclusively that *Cercospora musarum* was the only definite parasite involved. This organism produced a rapid discoloration when placed in small incisions in the skin of green bananas, and in about three weeks a lesion some two inches long was produced. The whole fruit is seldom affected and ripening appears to inhibit the further development of the lesion. At this stage, however, the affected area tends to split and the numerous insects thereby attracted, soon render the fruit unsaleable.

Influence of External Conditions.

Ogilvie states that the disease is most noticeable on both fruits and leaves during the summer months in Bermuda, (late June, July, August and September), when the mean maximum temperature is above 75° F. By the beginning of October, on the other hand, there is comparatively little discoloration of the tips of the very young fruits.

Control Measures.

Cercospora musarum in Bermuda is thus a definite parasite on young fruit under field conditions, high temperature being an important predisposing factor. Control measures are based on ameliorated plantation sanitation, since it has been found that greatest loss occurs in old, closely planted and badly drained fields. It is recommended that diseased fruit, trash, and large leaf infections should be removed.

5. Macrophoma Musae, Cke, Berl. and Vogl. (Phoma Musae, Carpenter).

This organism gives rise to "Freckle" or "Black Spot" disease of the banana and plantain. It has been reported by Carpenter [8] from Hawaii, by Campbell [6] from Fiji and by Reinking [20], [21], Ocfemia [17] and Lee [15] from the Philippine Islands.

Symptoms.

Lee states that green and mature banana fruits in public markets in the Philippines are commonly spotted with reddish-brown to black spots on which pycnidia appear. The disease is of long standing and occurs on practically all of the commercially important varieties of *Musa sapientum*. It does not seem to cause much damage since the fungus rarely penetrates deeper than the rind of the fruit. Ocfemia states that the spots are much more abundant on the upper than on the lower surface of the leaves. The upper exposed parts of the fruit may be entirely covered with the freckles so as to have a blackish appearance. The black spots are surrounded by a narrow band of more or less water-soaked tissue. In Hawaii Carpenter states that the disease has spread rapidly and is a serious pest in practically all the plantations of the Chinese or Dwarf banana (1918). The bunches of fruit from badly affected plants are undersized, discoloured, unevenly ripened, and unsuitable for export. Undersized fruit as well as undeveloped bunches may have to be cut prematurely as the result of disease. While the flesh may be unimpaired the extensive surface blemishing renders the fruit unsightly and unsuitable for export.

Conditions affecting the Disease.

Ocfemia states that under field conditions the spread of the disease appears to be effected by rain-water, secondary lesions being produced only on portions of the fruit and leaves washed by conidia-laden rain-water. According to Lee the disease is much more abundant at the close of the wet than during the dry season.

Varietal Susceptibility.

Reinking [21] states that while conducting an investigation in Hawaii it was observed that the Gros Michel banana of Central America appeared to be resistant to the disease, as no infection was noted on this variety even when growing adjacent to heavily infected bananas of the Chinese or Dwarf variety. The so-called red variety of Saba (Sabang Pula) in the Philippines is severely affected on both leaves and fruit.

Control.

According to Carpenter no satisfactory method of controlling this organism has yet been established, other than general sanitation and leaf spraying with Bordeaux mixture to keep down infection until the bunch appears and matures.

6. Verticillium Sp.

Dade [9] reporting on banana diseases from the Gold Coast has described a finger tip rot of the Canary Banana (*Musa cavendishii*) associated with a species of *Verticillium* (*Stachylidium*) which he considers as probably identical with a similar disease reported from the Canary Islands. Bensuade [5] also states that in S. Miguel, Azores, bananas are seriously affected by a disease attributed to a species of *Stachylidium*. A similar disease generally described as "Cigar End" is known in Panama, and in the Canary Islands and Madeira. The organism has also been described by Simmonds [22] in connection with Stem End Rot, and "Cigar End" in Queensland. Dade's brief account is as follows. The dead flowers adhere persistently to the fruit and a very imperfect cork layer is formed. Infection takes place by this path, after the preliminary infection, blackening and withering of the perianth have occurred. Rotting may proceed over one-third of the length of the fruit. *Rhizopus nigricans*, a saphrophytic mould follows the rot. Simmonds states that "Cigar End" is a disease to which the fruits are subject in their more immature stages. Commonly only a few of the fingers of the bunch exhibit the symptoms although sometimes the whole bunch is affected. His description is as follows :

"Affected fruit exhibit a firm black rot at the apex. The extent of the decay varies from a scarcely noticeable ring of black tissue round the terminal crown to a regular extension back for half an inch or more. The affected portion shrinks, in many cases becoming more or less rounded in contrast to the angular shape of the immature fruit. The blackened tissue then becomes covered from the distal end back with an ashy grey or sometimes pinkish-grey coat of fungal spores, which give, in typical cases, the striking resemblance to a burnt cigar tip to which the disease owes its name. The old shrivelled floral organs often persist for considerably longer than the normal period on affected fruit.

"A fungus (*Verticillium sp.*) is almost universally associated with 'Cigar End,' and it is the conidiospores and spores of this organism closely studded over the affected region which give rise to the grey covering characteristic of the disease. A consideration of the early stages of attack would suggest that infection may possibly take place through the tender floral structures which appear particularly susceptible to fungus invasion."

Control.

In the Canaries the disease causes much trouble and requires expensive hand control, namely the removal of pistil and perianth as soon as the fruit begins to form. Simmonds suggests that the young bunches should be opened up to the light and air and the bracts, which sometimes tend to remain attached to the developing hand, especially during wet weather, be removed as soon as possible.

7. Thielaviopsis paradoxa, Von Hohnel.

Roldan [18] showed by experimental inoculation that this organism was capable of attacking banana fruit, while more recently Hansford [12] has reported it as causing a rot of damaged banana fruit in Uganda.

8. Fusarium Spp.

So far as the writer is aware no species of *Fusarium* have been found to be directly parasitic on uninjured immature or maturing banana fruits. On the other hand they appear to be of frequent occurrence after preliminary infections by parasitic organisms have taken place. As disease tends to be extended and intensified by such saprophytic activity reference may be made to some of the species of *Fusarium* involved. Thus Ogilvie [16] found that the blackened tips of bananas which had been attacked by *Cercospora musarum* in moist weather frequently became covered by a growth of *Fusarium*. The latter was frequently found associated with withering flowers, while advanced stages of the *Cercospora* infection were frequently obscured by thick growths of *Fusarium*, *Cephalosporium* and other fungi. Campbell [6] in Fiji, mentions a condition possibly identical with "Black End" on bananas kept in the laboratory. Beginning at the upper part of the bunch the fingers become blackened and constricted at the stalk end and finally fall at a touch. A species of *Fusarium* which appears to be constantly associated with the disease was isolated and is suspected, but not yet definitely known, to be the cause of the trouble. Reinking and Wollenweber [19] have also given an account of *Fusarium* species associated with fruit diseases. Thus they found *F. pusillum* on sun-burned Congo fruit, *F. semitectum* on dead floral parts at the ends of banana fruits, and on diseased fruits, *F. camptoceras* on rotted fruit, *F. bullatum*, on dead floral parts at the tip of the fruit, *F. moniliforme* in the interior of diseased pseudo-stems, and on dead floral parts, &c. Hansford [13] has recorded similar isolations from Jamaica.

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WORKING CATTLE IN NYASALAND.

An article by H. C. Ducker in the issue of the *Empire Cotton Growing Review* for January, 1930, gives an account of the system of management of working oxen at the Makwapala Experiment Station, Nyasaland.

The animals at the station are the progeny of Shorthorn and Sussex bulls crossed with native cows containing a certain amount of Zebu blood. For working they are provided with a hemp nose-rope, three-eights inch in diameter, which is passed through a hole in the nose and knotted behind the horns. A yoke four feet long of the ordinary South African type is used—this is a straight unshaped pole with a wooden peg on either side of each animal's neck, a rope passing under the neck between the lower ends of the pegs.

For breaking, a pair of animals is yoked up and driven around the Station for an hour or so each day by means of reins made from a ten-foot length of cord attached to the nose ropes behind the horns. Whips are not used, neither are the drivers permitted to shout at the animals although a bamboo switch and ordinary words of command are allowed. When the bullocks have become accustomed to this procedure a small log is attached by a chain to the yoke. This is hauled over cultivated land and the training continues in this way until it is considered that the animals have learned to obey commands, and to draw a load sufficiently to justify their work on the plough. Of a bunch of eight beasts the first pair completed this course of training within a fortnight.

The working day consists of two shifts, 6 a.m. to 10 a.m. and 4 p.m. to 6 p.m. The oxen are kept in stalls at night and a daily grooming is practised. Feed consists of concentrates, various fodders and a certain amount of inferior grazing. The concentrates include a number of cereals and millets, the velvet bean, pigeon pea and cotton seed. Fodder crops include maize, various leguminous crops and elephant grass (*Pennisetum purpureum*). The latter makes good coarse hay, giving three cuts in a year with little cultivation.

The ration of concentrates varies from one and a half to three pounds daily according to the animal's condition and the amount of work being performed. This is moistened and given in the evening. A plentiful supply of fodder is given and a small handful of salt is supplied once a week.

The system appears to give satisfactory results and although the best stockmen are boys from the cattle-owning tribes, others have been trained to work efficiently with the animals.

As a principle, light implements and small teams (usually only one pair) of oxen are employed. Cultivation is carried out on the ridge system and where the ordinary four-foot yoke is found inconvenient one of eight feet is used; these measurements are made between the centre of the chines of the animals. When working among growing crops use is made of net bag muzzles made from Sunn Hemp fibre.

D. B.

DEFECTIVE DIET.

Notes on the Feeding of Indigenous Rats on Tannia and other Tubers, with special reference to the Question of Toxic Effects.

BY

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(I) INTRODUCTION.

THE research was undertaken to obtain further information on the significance of native carbohydrate storage tubers (tannia, yam, &c.) in relation to nutrition. This problem is of great importance to the West Indian Islands because the peasant relies on his own root crops as a main supplement to the imported rice and flour which he consumes. In particular it was desired to investigate the possibility of inducing the production of nephritis solely by a toxin from the assimilation of tannia. While a point of view on this subject has recently been expressed by Clark [1] working with albino rats, it appears to the writer that the problem has many sides. Clark expressed the view that tannia caused nephritis and haemolysis in rats and he suggested that these were brought about by saponin poisoning, and he also stated that tannia decoctions injected intramuscularly were lethal to guinea pigs. Saponin is present in the storage underground parts of a number of plants and is used medicinally in the case of senega. In the latter case it is present to the extent of producing a soapy froth on shaking and is used in cough medicines as an expectorant producing salivation, and an increased secretion of mucus by the mucous membrane of the bronchial tubes. Similar physiological properties have not been attributed to tannia. Again, solanin occurs in the Irish potato but does not appear to have any ill effect on the protoplasm of the multitudes who ingest it.

It was found that rats lived longer on tannia than on some other tubers, especially Irish potato, and further, that they invariably lived longer on cooked than uncooked tubers probably because the starch cells had burst and were more digestible. It was also observed with all tubers that the cultivated or matured roots were more beneficial dietetically than the wild and immature varieties. The tannia* of the West Indies, *Colocasia macrorrhiza*, resembles closely *Colocasia antiquorum* Var. *Esculenta*, the Taro of the South Pacific Islands. It is known as Mahogo in East Africa and Koko in West Africa, and is the Kolkas of the Arabs, Kamu of the Haussas and Kachu of India: the leaves when young are used as spinach. Together with dried plantains and palm oil, Taro tubers form the main food of the forest tribes of Ashanti, where no cereal crops are grown [2]. The other member of this family that is eaten in the West Indies is dasheen, and there is also malanga [3]. Despite the fact that the *Colocasia* species are grown and eaten throughout the tropics—forming indeed, in some parts, the staple article of diet—it is not possible to correlate a corresponding incidence of nephritis. For example, a great deal of tannia is eaten by the natives in Barbados and the Northern Islands, such as St. Lucia, but the incidence of nephritis is not unduly high in those particular places.

* At least two publications of the United States Department of Agriculture are concerned with the propagation and uses of these crops, *viz.*: *Farmer's Bulletin*, No. 1396, "The dasheen: A Southern Root Crop for Home Use and Market," and *Dept. Bull.* No. 1247, "Taros and tannias: Promising New Food Plants for the South."

(II)—EXPERIMENTAL METHODS.

The dietetic observations to be discussed were obtained from rat-feeding experiments. Indigenous rats were used, as albino rats would have had to be imported from England and bred under unaccustomed conditions. Diets included raw and boiled tannia, dasheen, yam, sweet potato, Irish potato, and also water decoctions of the various tubers. The rats were kept under observation until death, and notes were made of their condition at intervals. Post mortem examinations of each rat were made and the liver and kidneys were kept for sectioning and further examination. At intervals during life the urine was collected by trays and cottonwool and tested for albumin by the cold nitric acid test. At the post mortem examination, whenever possible, urine was drawn from the bladder by means of a fine needle and a syringe and examined for albumin and kidney casts. It may be pointed out that the latter are a much truer index of nephritis than the mere presence of albumin in the urine. Batches of rats of approximately equal weight and condition were fed upon one substance only, either raw or boiled tuber plus water, or else a water decoction of a tuber. Controls were given water only.

(III)—OBSERVATIONS.

(*a*) *General.*

Over 100 rats were used, divided into more or less equal groups. In each case water was fed to them so that there was no question of aqueous inanition. The groups of rats fed on boiled tubers fared consistently better than those on the raw article. Also if the tubers were mature and garden-cultivated the results were better than when immature or grown wild. One salient feature was that young rats as a rule lived longer on the unbalanced fare than old rats—the older ones seemed unable to adjust themselves to their altered conditions. Twenty rats fed on boiled tannia and water lived an average of 101 days. Of these, two which were young when caught have grown and thrived and are still alive to date, having lived so far, 271 and 351 days respectively. Other long durations were 124 days on raw tannia, in the case of one rat, and 201 days on boiled dasheen and 152 days on Irish potato for others.

Without dwelling at length on special cases such as these quoted above the average number of days lived on the various substances was as follows :—

Boiled tannia	101
Unboiled tannia	31
Boiled dasheen	136
Boiled yam	64
Unboiled yam	18
Boiled potato	28
Unboiled potato	15
Tannia water	8
Yam water	8
Potato water	3
Water only	3
Boiled brown rice	94

The results obtained by feeding rats on one type of tuber alone are very similar for the different varieties except that tannia and dasheen appeared to be able to sustain nutrition in indigenous rats for a longer period than yam, sweet potato or Irish potato. The degenerative changes in the tissues that bring about the ultimate death of the animals, suggest, in the case of all the tubers primarily, the direct effects of malnutrition upon the parenchymatous cells, rather than irritation or destruction by a toxic substance.

The average course of events and the pathological appearances suggest a generalised protein and vitamin A deficiency. Possibly the protein is of poor biological value. Davis and Cuthouse ('21), Osborne and Mendel ('17 and '20), Meyerstein ('22 , Beach ('23), and Herter ('97), all describe severe degenerative changes in the kidneys of albino rats and other animals as a result of vitamin A deficient diet. Recently Mellanby and Green [4] have demonstrated the fact that rats fed on diet deficient in vitamin A die readily from bacterial invasion of the tissues usually by septic organisms. The tubers under consideration appear to be very deficient in vitamin A. In dietetic experiments on rats it is very important to see that they get sufficient water as many observers have demonstrated the profound degeneration that occurs in parenchymatous cells of organs such as the kidney, in the case of total or partial aqueous inanition (Pernice and Scaglosi ('95) quoted by Jackson [5]).

Jackson quotes many workers who have found marked degenerative changes in the liver, kidneys and other organs of animals from the effects of total or partial inanition, either of protein, vitamins, salts, or water. In cases of "famine oedema" which is apparently not due to renal or cardiac insufficiency but probably to the direct effect of malnutrition upon the vascular endothelium, brought about by deficiency of protein and also of fat (vitamin A), albuminuria occurs and also kidney changes resembling chronic interstitial nephritis. A similar conditon occurs in parts of the West Indies as an "oedema disease" in young children and is quite an entity apart from nephritis or hookworm oedema, as it responds to treatment by increasing the proteins and vitamins in the diet alone.

Decoctions of tannia, prepared by boiling cut tubers in just sufficient water to cover them and then rendered isotonic with sodium chloride, were injected intramuscularly into rabbits in doses of 1 and 2 c.c. daily for long periods, producing absolutely no results. Then these decoctions made isotonic, were injected intravenously in 1 and 2 c.c. daily doses for periods of seven and ten days without detriment to the animals. Finally tannias were minced and the juice expressed from a lint bag in a vice. This extract was made isotonic and injected intravenously in two rabbits in doses of 1 c.c. for several days. No pathological change could be determined in the rabbits.

Human blood and rabbit blood were defibrinated and corpuscles were washed with isotonic saline and then mixed with isotonic extract and decoction of tannia respectively, but no haemolysis could be observed to take place *in vitro* and no marked changes were seen in the cytology of the corpuscles under the microscope.

(*b*) *Pathological Notes.*

There was much similarity in the way in which the rats fared on the different tubers. They were usually relatively normal until a week or so before death when they commenced to show marked loss of tissue and hair and then drowsiness and marked general muscular weakness. There was, however, no evidence of specific paralysis. No consistent cellular degeneration had taken place in the liver and kidneys but a few cases showed evidence of atrophy of liver cells and cloudy swelling with tubular degeneration in the kidneys, but these were exceptional and were about evenly distributed among the different batches. Further there was no evidence of altered kidney histology suggestive of a toxic glomerulo-tubular nephritis. Visceral hyperaemia was usually present but it is characteristic of the later stages of inanition and is due to cardiac weakness ; atrophy and degeneration of the parenchymatous cells to a degree varying with the resistance of the particular cells or organs is also characteristic of inanition. The delicate specialised cells of the kidney undergo great strain in inanition or altered metabolism and are likely to show effects earlier than other organs. The urine of one yam rat, one potato rat and two tannia rats showed albumin in the urine, but no blood or casts could be seen microscopically. The large intestine was frequently thinned and distended with masses of undigested vegetable fibre. In the case of tannia fed rats the viscera were often of a darker colour than otherwise was the case. When the post mortem examination was made immediately after death, the viscera did not give the prussian blue reaction when treated with a mixture of potassium ferrocyanide and hydrochloric acid, but this was obtained in direct proportion to the lapse of time after death owing to the rapid decomposition of blood in the tropical heat.

(IV)—Discussion of results.

(*a*) The ultimate decline of animals fed on tubers alone occurs much the same with each variety and there is much evidence that it is due

primarily to direct malnutrition of certain tissues probably from a generalised deficiency of protein and vitamin A. In the case of tannia no pathological evidence could be obtained to show that it contained a specific nephritis producing or blood destroying (haemolytic) toxic substance, and indeed it appeared to have life sustaining nutritive qualities rather superior to some of the other tubers.

(*b*) Regarding differences in longevity on boiled and unboiled tubers, two view points may be considered: (1) a specific toxin may be present which is destroyed by boiling; this would not apply to the saponin group of toxins because they are not destroyed by boiling. Furthermore, when the raw extracted juice was injected into animals it had no ill effect. (2) Modification of the feeding value may be due to the bursting of the starch grains by boiling, &c., and consequent greater digestibility.

(*c*) Considering the widespread use of tubers, especially of the tannia family, no positive correlation appears to exist between the incidence of nephritis and the amount of tannia used. As far as information and figures are available, this is true in each different country.

(*d*) The final test in a dietetic study such as this is whether or not tannia combined with a properly balanced diet is harmful. It may be mentioned that recent information has been obtained from America to the effect that the Bureau of Plant Industry in Washington, aware of the question, is advocating the planting of the Trinidad varieties of tannia and dasheen in the southern States in preference to other tubers, such as Irish potato, owing to their superior nutritive value. From indications such as this, taken in conjunction with the finding of the present investigation and further borne out by data collected during a Diet and Disease Survey that the writer has been conducting amongst agricultural labourers, there does not appear to be good reasons for indicting tannia on the grounds of a correlation between its consumption and the incidence of nephritis or anaemia.

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(2) A. Balfour.—*Practice of Medicine in the Tropics*, Vol. I.

(3) W. G. Freeman and R. O. Williams.—(The useful and ornamental plants of Trinidad and Tobago, 1928), state that Malanga may be used collectively for *Xanthosoma Sagittifolium X atro-virens or X violaceum.*

(4) The Committee of the Privy Council for Medical Research :—Report of the Medical Research Council for the year 1928-29. (pp. 66 and 79.)

(5) C. M. Jackson.—The Effects of Inanition and Malnutrition upon Growth and Structure. *J. and A. Churchill, London*, 1925.

SUGAR FROM MOLASSES*.

THE approximate composition of cane and beet molasses is as follows:—

	Cane Molasses.	*Beet Molasses.*
Water	20	20
Sucrose	34	45
Reducing sugars ..	22	traces only.
Non-sugars ..	24	35
	100	100

It will be seen that cane molasses contains less sucrose than beet molasses but appreciable amounts of reducing sugars (glucose and laevulose) are present in cane molasses, whereas only traces are contained in beet molasses.

The sugar lost annually in the World's molasses is estimated to be nearly 2,500,000 long tons, or nearly 10 per cent. of the total output of sugar.

The present uses for molasses can be classified as follows:—

(*a*) Production of alcohol and yeast.
(*b*) Sale as cattle food.
(*c*) Sale as edible product.
(*d*) Return to the soil.
(*e*) Extraction of sugar.

The methods of extraction of sugar from beet molasses are as follows:—

1. Friedrich and Rajtora Process.

This process depends on the partial precipitation of sugar when molasses is treated with concentrated acetic acid. The process has been tried out in Czecho-Slovakia in the Nestomitz factory refinery in 1923. The molasses was evaporated to a water content of five per cent., then 60 per cent. of acetic acid was added in the cold which precipitated from 70 per cent. to 75 per cent. only of the sugar originally present. The sugar crystals, however, were very fine and it was found difficult to separate them in the centrifugals. Furthermore the most important part of the process was the recovery of the acetic acid which proved costly and was not generally effected at Nestomitz.

2. Osmosis Process.

This was at one time extensively employed in France and Germany but has been gradually abandoned. The method aims at the separation of the impurities (salts and gums, &c.) from the sucrose by the different rates of diffusion across a parchment membrane (dialyser). In this way the saline constituents of the diluted molasses dialyse more rapidly than the sucrose.

The great disadvantage of the process is the large volume of water required to be evaporated owing to the dilution of the molasses during dialysis, and furthermore only 25 per cent. to 30 per cent. of the sucrose can be recovered from the molasses.

* Contributed to *Tropical Agriculture.*

3. Steffen Lime Process.

This process, known as the Steffen "separation" has been applied on the Continent and in United States of America for a number of years to the recovery of sugar from molasses. The principle depends on the formation of an insoluble saccharate of lime (*i.e.*, a combination of lime and sugar).

The operation of the Steffen process falls into three parts:—

(1) Preparation of a very finely divided quicklime.

(2) Formation of a tribasic saccharate in the cold.

(3) Extraction and purification of the saccharate.

In preparing the lime, a very pure non-siliceous stone is used, which is burned out of contact with the fuel. The burnt lime is brought by some means to a very fine state of division. In the United States, Raymond mills are exclusively employed. These mills separate the fine lime from the residue by means of an air blast.

In the second operation the molasses at a density of 10° to 20° Brix is cooled down to a temperature of 5° to 6°C., and the powdered quicklime is gradually added to the material until 210 parts of lime per 100 of sugar have been used. During the operation, the molasses is constantly agitated, and its temperature is not allowed to rise above 13° C. At the completion of the process there is obtained a pasty mass consisting of tribasic saccharate and lime. This precipitate is filtered off and washed with cold water, after which the washed cake is used in the treatment of fresh juice. The filtrates contain some sugar, and this is recoverable by boiling when an insoluble saccharate forms, which is recovered by filtration. In some cases the washings are run to waste as not being worth while treating.

There are certain disadvantages of the Steffen process compared to the Baryta process consisting principally as follows:—

(1) A very pure and finely pulverised lime is necessary.

(2) The molasses has to be considerably diluted (*i.e.*, to 10 to 12 Brix) and further more cooled, which last renders the treatment of cane molasses in the tropics very difficult, apart from the possibility of sucrose destruction during the elimination of reducing sugars.

(3) The recovery of sugar in the juice from the filtration of the carbonated saccharate does not exceed 89 to 90 per cent. of the original sugar of the molasses and furthermore the purity of this juice may be as low as 84 per cent. on account of non-elimination of raffinose and other impurities. The total recovery of white sugar from the molasses varies from 80 to 85 per cent. of the original sugar content.

4. Baryta Process.

This process was first patented by Dubrunfaut and Leplay in 1859, but has only comparatively recently been applied on a commercial scale to the extraction of sugar from beet molasses.

Ciancarelli has for a number of years studied the precipitation of barium saccharate from molasses and has worked up the process in Italian Beet Factories.

Baryta has the following advantages over lime in the extraction of sugar from molasses:—

(1) A well defined saccharate of barium is precipitated of a granular nature.

(2) There is no need for the special coolers necessary for the Steffen process as the precipitation occurs best at 63°C. to 66°C.

(3) The precipitation takes place at a much greater density, *i.e.*, 66 Brix instead of 10 to 12 Brix, and furthermore the recovery of sugar is considerably higher; *i.e.*, 95 to 97 per cent. in juice compared to 89 to 90 per cent.

(4) Raffinose does not contaminate the saccharate but passes into the mother liquor, so the purity of the juice is higher after the carbonatation of the saccharate than in the Steffen process, *i.e.*, 93 to 96 per cent. compared to 84 to 90 per cent.

While baryta is much more satisfactory than lime for the precipitation of sucrose its greater cost has hitherto prevented its being more widely used.

The high cost of baryta necessitates its recovery and regeneration if the process is to be a commercial success.

During the carbonatation the baryta $Ba(OH)_2$ is converted into insoluble barium carbonate $BaCO_3$ and therefore baryta must somehow be regenerated from this barium carbonate.

If barium carbonate is heated it decomposes at 1600°C. into barium oxide (BaO) and carbon dioxide$(CO)_2$ the barium oxide being subsequently mixed with water to form baryta.

Barium carbonate, however, fuses at 1200°C., *i.e.*, below its decomposition point, and the fused substance attacks the bricks of the furnace and moreover prevents the complete decomposition. If, on the other hand, the temperature lies below the fusion point there is only a partial decomposition.

The decomposition of barium carbonate by heat more nearly approaches completion if it is mixed with carbon or coal.

$BaCO_3 + C$ [$= BaO + 2$ CO.]

The Belgian Chemist, Deguide, in 1921 took out patents in nearly every country in the world for a new industrial and economical process of manufacturing baryta, based on his researches which were begun in 1913.

The basis of the Deguide process lies in the formation of the barium silicate which is subsequently decomposed by water reforming baryta and mono barium silicate.

Deguide found that by raising the temperature of a molecular mixture of three parts of barium carbonate and one part of silica to between 1300 and 1453°, the following fundamental reaction takes place:—

$$3\ BaCO_3 + SiO_2 \longrightarrow (3\ BaO)\ SiO_2 + 3\ CO_2$$

the silicate obtained being infusible, even at a temperature of 1750°C.

On the other hand, Deguide discovered that by adding hot water to the tertiary barium silicate thus obtained, this silicate decomposes into primary barium silicate, freeing two molecules of barium hydrate, according to the equation :—

$$(3\ BaO).\ SiO_2 + 2H_2O = BaO.\ SiO_2 + 2\ Ba\ (OH)_2.$$

This second reaction furnishes a means of obtaining barium hydrate, one of the raw materials from which barium sucrate is formed.

Deguide further showed that, working under similar conditions but with different molecular quantities of barium carbonate and silica, a secondary barium silicate could be obtained, which, on contact with water, liberated about one molecule of barium hydrate.

$$2\ Ba\ CO_3 + SiO_2 = (2BaO).\ SiO_2 + 2\ CO_2.$$

$$(2\ BaO).\ SiO_2 + H_2O = BaO.\ SiO_2 + Ba\ (OH)_2.$$

For various economic reasons which are given further on, Deguide has found that it is more advantageous, industrially, to make an intermediary silicate, between secondary and tertiary barium silicate (5 BaO). $2SiO_2$ a product which is absolutely infusible at the temperatures of reaction (1250°C.) and which gives about 70 per cent. of its weight in barium hydrate:—

$$(5\ BaO).2SiO_2 + 2H_2O = (3BaO)\ 2SiO_2 + 2\ Ba\ (OH)_2.$$

The Deguide process possesses a great industrial advantage, the reactions taking place at temperatures between 1250°C. and 1300°C. and the melting point of these silicates being nearly 1750°C.

It is clear that a considerable margin exists, ensuring that in no case will the melting of the silicate occur, which, as will be shown later, represents a very great advantage industrially.

This infusibility of the barium silicates gave Deguide reason to believe that the manufacture could be carried on with continuous apparatus (rotary furnaces) and with the same ease as in Portland Cement making.

The different stages involved in the production of baryta and subsequent precipitation of sucrose from beet molasses are as follows:—

(*a*) Production of silicate clinker.
(*b*) Lixiviation and hydrolysis of clinker.
(*c*) Recovery of barium "paste."
(*d*) Precipitation and washing of barium sucrate.
(*e*) Carbonation of barium sucrate.
(*f*) Filtration of sucrate juice, concentration and separation of sugar crystals, and recovery of barium carbonate.

The Deguide process has been operated both in France and Belgium and has also been adapted to the recovery of sugar from American beet molasses after a preliminary Steffen treatment.

The process works without technical difficulties but of course the economics depend on the relationship between the price of molasses and the price of sugar.

The cost in Great Britain of recovering sugar from one ton of average beet molasses is approximately £3 10*s*. or over £8 per ton of refined sugar recovered. Under Continental conditions the costs are substantially reduced and one ton of molasses can be treated for £2 15*s*.

Bearing in mind that the present price of beet molasses in the United Kingdom is over £4 per ton (in bond) and that approximately two and a third tons of molasses are required for one ton of sugar produced, it is obvious that it would not at present pay to recover the sugar. Furthermore in England a subsidy is payable on molasses and the beet factories prefer to sell the molasses and collect the subsidy rather than to recover the sugar. If, however, the price of sugar rises, and bearing in mind that the subsidy is abolished in 1934, it is quite possible that the sugar will be extracted from molasses in the near future.

The Extraction of Sugar from Cane Molasses.

Owing to the presence of glucose the precipitation of barium or calcium sucrate is rendered almost impossible, and means have to be found to destroy the glucose and gums by heating in alkaline solutions. This has been accomplished both by Batelle and by Deguide who have worked with lime and barium silicate (3 BaO $2SiO_2$) respectively. The sucrate can then be precipitated, carbonated as usual and the sugar crystallised. The process has not yet emerged from the experimental stage and it would appear that during the preliminary elimination of glucose, there is some slight destruction of sucrose. It must be borne in mind that in any case cane molasses, owing to its composition, does not yield the same quantity of sucrose as beet molasses.

Work has been conducted in the United States of America on the selective fermentation of the reducing sugars in cane molasses with the production of alcohol. After the removal of the glucose in this way the sucrose can be precipitated from the residue.

It is believed that the Osmosis process has been applied to the extraction of sugar from cane molasses in the Far East but results are not available.

It is obvious that with any widening in the price margin increased attention will be paid to the extraction of sugar from molasses.

THE EDITOR requests that any subscriber who fails to receive *Tropical Agriculture* regularly should communicate with him immediately in order that the matter may be rectified.

FIELD EXPERIMENTS.

ON SUGAR-CANE.

Concluded.

III.—General Manurial Trials.

(A)—Calcareous Soils.

Experiment III.

General Experiment to Estimate the Value of Inorganic Manures, with Special Stress on the Dose of Nitrogen.

1.—*Quantities of Inorganic Manures per Acre.*

K_2O. Sulphate of Potash at rate of 150 lb. K_2O.

P_2O_5. Superphosphate at rate of 150 lb. P_2O_5.

N. Sulphate of Ammonia. Four treatments:

No Nitrogen. (N_0).
40 lb. Nitrogen (N_1).
80 lb. do. (N_2).
120 lb. do. (N_3).

The amounts of K_2O and P_2O_5 are largely in excess of those normally used in estate practice in the West Indies. Relatively large dressings are suggested, partly because of the success with which they are being used in Hawaii, and partly to ensure that the heavy dressings of nitrogen will have their full effect.

The regular variation in the quantity of nitrogen applied enables the general form of the yield-treatment relationship to be tested.

2.—*Method of Combination of Manures.*

The K_2O and P_2O_5 to be combined in every possible way, viz.:—

(I) No K_2O or P_2O_5.
(II) P_2O_5 only.
(III) K_2O only.
(IV) K_2O and P_2O_5.

Each of these four combinations to be further combined with the four amounts of sulphate of ammonia.

3.—*Plot Treatments.*

This gives rise to the following 16 plot treatments.

T_1. No treatment	T_9. K_2O alone
T_2. N_1 alone	T_{10}. K_2O+N_1
T_3. N_2 alone	T_{11}. K_2O+N_2
T_4. N_3 alone	T_{12}. K_2O+N_3
T_5. P_2O_5 alone	T_{13}. $K_2O+P_2O_5$
T_6. $P_2O_5+N_1$	T_{14}. $K_2O+P_2O_5+N_1$
T_7. $P_2O_5+N_2$	T_{15}. $K_2O+P_2O_5+N_2$
T_8. $P_2O_5+N_3$	T_{16}. $K_2O+P_2O_5+N_3$

4. *Lay-out of Plots.*

These 16 treatments to be scattered at random in Block 1. There to be at least three replicates of this block in the set.

Set I.

11	10	3	15
9	14	7	12
1	8	6	13
5	16	2	4

10	15	3	6
4	1	13	8
7	5	14	11
9	12	16	2

5	3	10	9
8	13	1	12
4	2	16	7
14	6	15	11

5.—*Area of Plots*—One-twentieth to one-tenth acre for estate conditions.

6.—The *Yield Data* obtained could be arranged as follows:—

	Potash absent.		Potash present.		
	Phosphate absent.	Phosphate present.	Phosphate absent.	Phosphate present.	Means.
No Nitrogen.	T_1	T_5	T_9	T_{13}	mN_0
40 lb. N.	T_2	T_6	T_{10}	T_{14}	mN_1
80 lb. N.	T_3	T_7	T_{11}	T_{15}	mN_2
120 lb. N.	T_4	T_8	T_{12}	T_{16}	mN_3
	mK_0P_0	mK_0P_1	mK_1P_0	mK_1P_1	
	mK_0			mK_1	
	mP_0		mP_1		

mN_o, mN_1, &c., are means of all N_o, N_1, &c., treatments.

mK_oP_1 is mean of all treatments in which potash is absent and phosphate present.

The major effects of the nitrogen dose are determined on the means of four treatments at a time, *i.e.*, 12 plots if there are three blocks.

The major effects of potash and of phosphate are determined on the means of eight treatments at a time, *i.e.*, 24 plots if there are three blocks.

The intearction between potash and phosphate is determined on the means of eight treatments at a time, *i.e.*, 24 plots if there are three blocks, *i.e.*, the interaction tests whether the effect of giving the two manures together is different from the sum of the effects of giving them separately $[(mK_1P_1 + mK_oP_o)/2 - (mK_oP_1 + mK_1P_o)/2.]$.

Experiment IV.

General Experiment to Estimate the Value of Pen Manure in the Presence and Absence of Artificials.

1.—*Quantities of Manures per Acre.*

K. Sulphate of Potash at rate of 150 lb. K_2O.

P. Superphosphate at rate of 150 lb. P_2O_5.

N. Sulphate of Ammonia at rate of 60 lb. N.

Pen Manure. Four treatments.

T_o No pen manure.

T_1 10 tons pen manure.

T_2 20 do.

T_3 30 do.

2.—*Method of Combination of Manures.*

The potash, superphosphate and nitrogen are combined in every possible way with the four doses of pen manure. The 32 combinations of factors are separated into two series of 16, in such a manner that every possible combination of three factors at a time appears once in each series. The 16 combinations of one series are scattered at random in Half-Block I (*a*), and those of the other series in Half-Block I (*b*).

Three alternative sets of combinations are possible in each of the two series, viz. :—

	Block I.		Block II.		Block III.	
	I (*a*)	I (*b*)	II (*a*)	II (*b*)	III (*a*)	III (*b*)
$K_oP_oN_o$, $K_oP_1N_1$, $K_1P_oN_1$, $K_1P_1N_o$ combined with ..	T_1 & T_2	T_3 & T_o	T_1 & T_3	T_2 & T_o	T_1 & T_o	T_2 & T_3
$K_oP_oN_1$, $K_oP_1N_o$, $K_1P_oN_o$, $K_1P_1N_1$ combined with ..	T_3 & T_o	T_1 & T_2	T_2 & T_o	T_1 & T_3	T_2 & T_3	T_1 & T_o

The three possible alternatives may advantageously form three separate randomised blocks (the minimum number of blocks which should be included in the experiment).

3.—*Plot Treatments.*

1. $T_1K_oP_oN_o$	9. $T_2K_oP_oN_o$	17. $T_3K_oP_oN_o$	25. $T_oK_oP_oN_o$
2. $T_1K_oP_oN_1$	10. $T_2K_oP_oN_1$	18. $T_3K_oP_oN_1$	26. $T_oK_oP_oN_1$
3. $T_1K_oP_1N_o$	11. $T_2K_oP_1N_o$	19. $T_3K_oP_1N_o$	27. $T_oK_oP_1N_o$
4. $T_1K_oP_1N_1$	12. $T_2K_oP_1N_1$	20. $T_3K_oP_1N_1$	28. $T_oK_oP_1N_1$
5. $T_1K_1P_oN_o$	13. $T_2K_1P_oN_o$	21. $T_3K_1P_oN_o$	29. $T_oK_1P_oN_o$
6. $T_1K_1P_oN_1$	14. $T_2K_1P_oN_1$	22. $T_3K_1P_oN_1$	30. $T_oK_1P_oN_1$
7. $T_1K_1P_1N_o$	15. $T_2K_1P_1N_o$	23. $T_3K_1P_1N_o$	31. $T_oK_1P_1N_o$
8. $T_1K_1P_1N_1$	16. $T_2K_1P_1N_1$	24. $T_3K_1P_1N_1$	32. $T_oK_1P_1N_1$

4.—*Lay-out.*

I (a).

18	24	27	15
1	9	12	4
14	6	26	32
21	19	29	7

II (a).

27	32	11	6
17	26	4	22
1	23	13	20
29	16	10	7

III (a).

23	29	9	27
2	12	17	14
3	20	5	32
8	22	26	15

I (b).

22	23	17	13
31	28	16	30
3	11	5	2
20	10	25	8

II (b).

9	30	18	2
14	19	25	8
31	15	3	5
28	24	12	21

III (b).

19	25	10	21
24	31	1	4
18	16	28	13
7	30	6	11

5.—*Area of Plots.*

One-twentieth to one-tenth acre for estate conditions.

6.—The information obtained can be summarised as follows:—

Major Effects.

The average effect of any one fertiliser or one amount of pen manure.

Interactions.

The effect on the response shown to any one fertiliser or one amount of pen manure of the presence or absence of (*a*) any one other fertiliser; (*b*) any other pair of fertilisers supplied together.

The object of separating the 32 possible combinations of factors into two comparable sets of 16, is, by halving the area of the blocks, to increase control over soil heterogeneity. There is the disadvantage that it thereby becomes impossible to measure fourth order interactions, but in a field experiment these are likely to be of the same order as the plot error.

7.—The yield data obtained may be arranged with advantage as under:

Pen Manure Treatment.	Potash absent.				Potash present.				Mean.
	Phosphate abs.		Phosphate pres.		Phosphate abs.		Phosphate pres.		
	N. abs.	N. pres.	N. abs.	N. pres.	N. abs.	N. pres.	N. abs.	N. pres.	
No Pen manure.									mT_0
10 tons.									mT_1
20 tons.									mT_2
30 tons.									mT_3
Means	$mK_0P_0N_0$	$mK_0P_0N_1$	$mK_0P_1N_0$	$mK_0P_1N_1$	$mK_1P_0N_0$	$mK_1P_0N_1$	$mK_1P_1N_0$	$mK_1P_1N_1$	M

The experience gained from the above experiment should be invaluable in planning a scheme to estimate the extent to which pen manure may be replaced by artificials.

Experiment IV (a).

Experiment IV is put forward as a complete scheme, and serves to illustrate the method of half-blocks in cases where the number of plot treatments is large. It could be simplified by neglecting the separate effects of potash and phosphate. There would then be three factors only:—

(1) Mineral manures (P and K);

(2) Nitrogen (Sulphate of Ammonia);

(3) Pen manure (in four doses);

which would give rise to 16 plot treatments, all of which could be included in one block. There should be at least three replicates of each block.

Such a simplification of the complete scheme would render it impossible to test whether any effect of mineral manures is due to potash or phosphate. From the point of view of expenditure on fertilisers, this information would be valuable.

(B) Non-Calcareous Soils.

Experiment V.

General Experiment to Estimate the Value of Inorganic and Organic Manures, with Special Stress on the Dose of Nitrogen.

1.—*Quantities of Fertilisers per Acre.*

Lime. Lime requirement + four tons ground limestone.
K_2O. Sulphate of Potash at rate of 150 lb. K_2O.
P_2O_5. Superphosphate at rate of 150 lb. P_2O_5.
N. Sulphate of Ammonia. Four treatments.

No Nitrogen	(N_0).
40 lb. Nitrogen	(N_1).
80 lb. do.	(N_2).
120 lb. do.	(N_3).

Pen manure. Four treatments.

No pen manure	(T_0).
10 tons pen manure	(T_1).
20 do.	(T_2).
30 do.	(T_3).

2—*Method of Combination of Manures.*

(*a*) *Lime, Potash, Superphosphate, and Sulphate of Ammonia.*

The lime, potash and superphosphate are combined in every possible way with the four doses of nitrogen. The 32 combinations of factors are separated into two series of 16, in such a manner that every possible combination of three factors at a time appears once in each series. The combinations of one series are scattered at random in Half-Block I (*a*), and those of the other series in Half-Block I (*b*).

As in Experiment IV, three alternative sets of combinations are possible in each of the two series. They may advantageously form three separate randomised blocks, viz. :—

	Block I.		Block I'.		Block I".	
	I (*a*)	I (*b*)	I' (*a*)	I' (*b*)	I" (*a*)	I" (*b*)
$K_0P_0Ca_0$, $K_0P_1Ca_1$, $K_1P_0Ca_1$, $K_1P_1Ca_0$ } combined with ..	N_1 & N_2	N_3 & N_0	N_1 & N_3	N_2 & N_0	N_1 & N_0	N_2 & N_3
$K_0P_0Ca_1$, $K_0P_1Ca_0$, $K_1P_0Ca_0$, $K_1P_1Ca_1$ } combined with ..	N_3 & N_0	N_1 & N_2	N_2 & N_0	N_1 & N_3	N_2 & N_3	N_1 & N_0

(*b*) *Pen Manure and Lime.*

The four quantities of pen manure alone and each in combination with lime to be scattered at random in a second block (Block II).

The combinations of pen manure with artificial fertilisers in the presence and absence of lime, are omitted from this block to prevent the experiment becoming unwieldy.

3.—*Plot Treatments.*

(*a*) *Block I.*

1. $N_1K_0P_0Ca_0$	9. $N_2K_0P_0Ca_0$	17. $N_3K_0P_0Ca_0$	25. $N_0K_0P_0Ca_0$
2. $N_1K_0P_0Ca_1$	10. $N_2K_0P_0Ca_1$	18. $N_3K_0P_0Ca_1$	26. $N_0K_0P_0Ca_1$
3. $N_1K_0P_1Ca_0$	11. $N_2K_0P_1Ca_0$	19. $N_3K_0P_1Ca_0$	27. $N_0K_0P_1Ca_0$
4. $N_1K_0P_1Ca_1$	12. $N_2K_0P_1Ca_1$	20. $N_3K_0P_1Ca_1$	28. $N_0K_0P_1Ca_1$
5. $N_1K_1P_0Ca_0$	13. $N_2K_1P_0Ca_0$	21. $N_3K_1P_0Ca_0$	29. $N_0K_1P_0Ca_0$
6. $N_1K_1P_0Ca_1$	14. $N_2K_1P_0Ca_1$	22. $N_3K_1P_0Ca_1$	30. $N_0K_1P_0Ca_1$
7. $N_1K_1P_1Ca_0$	15. $N_2K_1P_1Ca_0$	23. $N_3K_1P_1Ca_0$	31. $N_0K_1P_1Ca_0$
8. $N_1K_1P_1Ca_1$	16. $N_2K_1P_1Ca_1$	24. $N_3K_1P_1Ca_1$	32. $N_0K_1P_1Ca_1$

(*b*) *Block II.*

33. Ca_0 T1	35. Ca_0 T3	37. Ca_1 T1	39. Ca_1 T3
34. Ca_0 T2	36. Ca_0 To	38. Ca_1 T2	40. Ca_1 To

4.—*Lay-out.*

I (*a*)			
18	24	27	15
1	9	12	4
14	6	26	32
21	19	29	7

II	
33	35
37	40
36	39
34	38

I (*b*)			
22	23	17	13
31	28	16	30
3	11	5	2
20	10	25	8

I′ (*a*)			
27	32	11	6
17	26	4	22
1	23	13	20
29	16	10	7

I′ (*b*)			
9	30	18	2
14	19	25	8
31	15	3	5
28	24	12	21

II′	
37	38
35	33
40	39
36	34

II″	
39	37
35	36
34	40
33	38

I″ (*a*)			
23	29	9	27
2	12	17	14
3	20	5	32
8	22	26	15

I″ (*b*)			
19	25	10	21
24	31	1	4
18	16	28	13
7	30	6	11

5.—*Area of Plots.*

One-twentieth to one-tenth acre for estate conditions.

6.—The nature of the information obtained, and the arrangement of yield data, is similar to that described in Experiment IV.

7.—In cases where it is desired to compare the relative merits of superphosphate and rock phosphate, the plots receiving phosphate applications (*i.e.*, plots 3, 4, 7, 8, 11, 12, 15, 16, 19, 20, 23, 24, 27, 28, 31 and 32) may be sub-divided into two, and one form of phosphate applied to each half-plot. The arrangement of the half-plots within each plot should be determined by random choice.

Experiment V I.

To Estimate the Value of Pen Manure on Artificial Fertilisers in the Presence and Absence of Lime.

This is the only important manure and fertiliser interaction not included in Experiment V.

1.—*Quantities of Manures and Fertilisers per Acre.*

Lime. Ground limestone at rate of lime requirement+four tons.

N. Sulphate of ammonia at rate of 60 lb. N.

K_2O. Sulphate of potash at rate of 150 lb. K_2O.

P_2O_5. Superphosphate at rate of 150 lb. P_2O_5 per acre.

Pen manure at rate of 20 tons per acre.

2.—*Plot Treatments.*

1. $N+K_2O+P_2O_5$).
2. $(N+K_2O+P_2O_5)$+pen manure.
3. $(N+K_2O+P_2O_5)$+lime.
4. $(N+K_2O+P_2O_5)$+pen manure+lime.

3.—*Lay-out.*

To be in form of a 4×4 Latin Square. There to be at least four replicates of each Latin Square.

2	3	1	4
1	2	4	3
4	1	3	2
3	4	2	1

1	2	4	3
2	4	3	1
4	3	1	2
3	1	2	4

3	2	4	1
4	1	3	2
2	3	1	4
1	4	2	3

4	2	3	1
3	1	4	2
1	3	2	4
2	4	1	3

4.—It should be noted that this scheme does not render it possible to test whether any effect of Treatment I is due to the nitrogen, potash or phosphate. From the point of view of expenditure on fertilisers, this information would be valuable.

IV.—Special Manurial Trials.

Experiment V I I.

To Estimate the Effect of Heavy Applications of Phosphate and Potash in the Presence of Low and High Applications of Nitrogen.

This experiment is suggested by the excellent results obtained by Mr. W. P. Naquin of Plantation Honokaa, with high phosphate and potash applications under dry climatic conditions.

1.—*Quantities of Fertilisers per Acre.*

Sulphate of Ammonia.	Three treatments.
0 lb. N	(N_0).
40 lb. N	(N_1),
120 lb. N	(N_3).

Sulphate of Potash.	Three treatments.
0 lb. K_2O	(K_0).
150 lb. K_2O	(K_1).
450 lb. K_2O	(K_3).

Superphosphate.	Three treatments.
0 lb. P_2O_5	(P_0).
150 lb. P_2O_5	(P_1).
450 lb. P_2O_5	(P_3).

2.—*Combination of Fertilisers.*

For the complete block, the three doses of *N*, *P* and *K* are combined in every possible way (27 combinations), but for the better control of soil heterogeneity, each block is sub-divided into three sub-blocks, each of which contains every combination of two factors at a time.

3.—*Plot Treatments for each Sub-Block.*

Sub-Block I.	*Sub-Block II.*	*Sub-Block III.*
(1) P_3	(10) P_1	(19) N_3P_1
(2) K_1P_1	(11) K_1	(20) N_3K_1
(3) K_3P_0	(12) K_3P_3	(21) $N_3K_3P_3$
(4) N_1P_1	(13) N_1	(22) No treatment.
(5) N_1K_1	(14) $N_1K_1P_3$	(23) K_1P_3
(6) $N_1K_3P_3$	(15) $N_1K_3P_1$	(24) K_3P_1
(7) N_3	(16) N_3P_3	(25) N_1P_3
(8) $N_3K_1P_3$	(17) $N_3K_1P_1$	(26) $N_1K_1P_1$
(9) $N_3K_3P_1$	(18) N_3K_3	(27) N_1K_3

4.—*Lay-Out.*

At least three replicates of each sub-block (nine sub-blocks in all).

(*a*)

5	1	3
6	8	2
7	9	4

(*b*)

13	15	10
12	16	14
17	11	18

(*c*)

22	19	24
23	26	21
25	20	27

(*c*)

26	23	24
19	25	22
21	27	20

(*a*)

9	8	2
3	6	7
4	1	5

(*b*)

15	10	14
11	16	13
17	18	12

(*b*)

17	12	14
13	16	11
15	10	18

(*c*)

24	23	26
20	25	19
27	21	22

(*a*)

8	3	4
7	6	5
2	9	1

5.—The division of each block into sub-blocks makes impossible the investigation of third order interactions, *e.g.*, we cannot test whether the effect of adding potash and phosphate together, in the presence of high nitrogen, is greater than, or only the same as, the sum of the effects of potash and phosphate when applied separately. At the risk of determining the average response to nitrogen with somewhat diminished accuracy, such information could be obtained by re-arranging the lay-out as in Experiment VII (*a*).

Experiment V I I (a).

Each block would consist of three large plots, representing the three doses of nitrogen. Each of these large plots would be sub-divided into nine sub-plots, representing all possible combinations of the potash and phosphate applications.

1.—*Sub-Plot Treatments.*

1. K_0P_0
2. K_0P_1
3. K_0P_3
4. K_1P_0
5. K_1P_1
6. K_1P_3
7. K_3P_0
8. K_3P_1
9. K_3P_3

2.—*Lay-out.*

	N_0			N_3			N_1		
Block I.	8	9	5	6	3	7	1	3	4
	7	3	6	2	9	4	8	6	2
	4	1	2	1	8	5	5	7	9

	N_3			N_1			N_0		
Block II.	3	1	2	7	3	4	2	5	4
	4	8	7	2	8	9	7	6	3
	9	5	6	6	1	5	9	8	1

	N_1			N_2			N_3		
Block III.	5	8	6	3	9	4	2	8	4
	3	7	2	2	1	6	6	9	7
	1	9	4	8	5	7	1	3	5

COTTON NOTES.

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Natural Crossing and the Preservation of Pure Lines in Cotton.

In recent years the conception has arisen that a systematic species can be broken up into a number of true breeding little species—the "elementary species" of de Vries, or "biotypes" of Johannsen. Such biotypes have been observed in many plants, both wild and cultivated, but only in plants which are normally self fertilising. In cotton the large assemblage of Peruvian and Bourbon cottons of the West Indies found growing wild and semi-wild in native gardens and along the roadside are made up of many distinct "elementary species," differing in such characters as abundance and amount of seed fuzz, lint length, hairiness, corolla and pollen colour, &c., but breeding true to a particular association of characters. Any single one of these plants gives rise to a uniform progeny. When we come to examine an ordinary field of commercial cotton however, we are bewildered by the variability from plant to plant. Progenies of single plants do not give uniform offspring but exhibit segregation of characters to a greater or less extent.

Genetic studies have familiarised us with the fact that self-fertilization of even the most complex hybrids leads in time to the production of types which breed true, or in other words leads to the production of homozygous combinations of various characters. The uniformity attained applies not only to morphological characters, but also to such physiological characters as yielding capacity under defined environmental conditions.

In many parts of the world biotypes or pure lines of cotton have been isolated and are grown on a commercial scale. The Sea Island cottons of Montserrat and St. Vincent have been subjected to continued self-fertilization for some fourteen generations and can be regarded as homozygous. Such variability as is found in lint quality, yield, resistance to disease, seed weight, and lint weight, is the result of environmental conditions and not of hereditary constitution.

After the cotton breeder has isolated in Sea Island desirable pure lines free from such abnormalities as naked seed, white flower, crinkled dwarf, &c., he is confronted with the task of keeping the strain pure. Deterioration of a pure line, as has been repeatedly emphasised by Balls, takes place comparatively rapidly under the influence of natural crossing with commercial varieties. In a large country it is probable that many different pure lines will have to be grown, since climatic conditions will vary from one part of the country to another and natural crossing will take place at the boundary of the region devoted to a given pure line. There is also another difficulty. After the pure line has been obtained, how often will mutation occur? It was formerly held by Balls that once a pure line was obtained it would, so far as available knowledge went continue to breed true for an indefinite period. At present we are not so sure of this. In Montserrat the mutation to naked seed, which has the effect of removing about 25 per cent. of the lint from the seed has been observed to occur fairly often, and the writer has also frequently observed a mutation to white flower accompanied by shorter lint. Mutation from normal to crinkled dwarf has been recorded in the St. Vincent pure lines more than once. These observations must lead us to consider the possibility that a pure line may, after a few generations become contaminated with undesirable types. Exact studies of the mutation rate in plants and animals are rare, though there is some evidence which indicates that certain factors mutate relatively frequently.

Muller and Altenburg concluded that mutation to lethal in the x chromosome occurred at the rate of 1 in 53.

Zeleny studied the frequency of mutation for full, bar and ultra bar eye in Drosophila. The mutation rate varied from 35 to 61 per 100,000. There is some evidence that the mutation rate varies with the gene concerned. Emerson working with the multiple allelomorph series of pericarp colours in maize says: "some of the factors of this series have not been observed to mutate, while others have mutated rarely and still others many times." Hayes and Brewbaker state that the relative frequency of occurrence of chlorophyll deficient mutants in maize apparently varies with the variety. This accords with our experience with Sea Island cotton. The naked seeded mutant so common in Montserrat has so far not been recorded so far as the writer is aware in the Sea Island strains of St. Vincent.

Hayes and Brewbaker have obtained figures showing the frequency with which mutation to chlorophyll deficiency occurs in Minnesota maize. A total of 953 lines varying from two to nine years selfed are recorded as having no seedling chlorophyll deficiencies. Four of the progenies of selfed ears in these lines segregated for deficiency. These are assumed to have arisen by mutation, and the mutation rate was calculated to be 422 per 100,000. This value is higher than that obtained by Zeleny, and may be due to the fact that mutation in more than one locus was concerned, since all the deficiencies were not alike.

For the present therefore we may conclude provisionally that mutation in a pure line of cotton may occur to the extent of at least 30 per 100,000, so that in a country such as Egypt where several million plants are grown annually, and where the amount of seed required renders it impracticable to renew frequently from the original source, the mutation factor cannot be entirely neglected.

Nevertheless the degeneration of a pure line through mutation is a phenomenon of the second order compared with the contamination which may occur by natural crossing.

Webber stated that five to ten per cent. of natural crossing occurs in the United States. Allard believed that at least 20 per cent. with a strong probability of 40 per cent. of flowers are crossed. In Egypt, Balls found 13.3 per cent. of natural crosses in his cultures in 1904 and stated that five to ten per cent. of natural crossing occurs under field conditions. Cook considered that natural crossing took place with such frequency in the United States that he elaborated the method of securing first generation hybrids by growing adjacent rows of different types, and making use of the naturally crossed seedlings. Brown carried out experiments in Louisiana in which a red leaf variety of Upland was grown in alternate rows with ordinary Upland. Natural crossing between adjoining rows ranged from 1.6 per cent. to 14.7 per cent. averaging 6.2 per cent. A limited amount of crossing was observed at more than 100 yards. Individual green leaf plants scattered in a plot of red leaf cotton had more than 30 per cent. of the seed crossed.

Beginning with the pioneer work of Balls, several authors (Kearney, Zaitzev and Trought) have established the fact that self pollen is prepotent over foreign pollen, at least in inter-specific crosses. Zaitzev stated that the more genetically different the form the more at a disadvantage foreign pollen is compared with self pollen. This fact is admirably substantiated by a series of observations made by the present writer in the Grenadines group of the Windward Islands. Here the perennial cotton under cultivation consists of a mixture of types belonging to the Peruvian and Bourbon groups respectively. In spite of the abundance of agents causing natural crossing there is very little evidence of hybridisation between the two forms and pedigree selections breed fairly true to one or the other type. This means that either the hybrid types are at a considerable disadvantage compared with the specific types, or there is great prepotency of self pollen. A collection of cottons from North Brazil show the same mixture of Peruvian and Bourbon and out of over 200 plants all were Peruvian or Bourbon except one, which was an undoubted hybrid.

Little exact information seems to be available in regard to the percentage of natural crossing between two Egyptian types, but Kearney planted seeds gathered from a row of Pima adjacent to a row of Gila. Hybrids formed 2.3 per cent. of the resulting population. Trought (*Emp. Cotton Grow. Rev.* 7, No. 1, pp. 13-18), by pollinating Wrinkled leaf dwarf simultaneously with Wrinkled leaf and Sakel obtained seven seedlings showing 85.7 per cent. of hybrids.

Where propagation plots of pure seed are adjacent to other plots of different varieties of cotton it is becoming customary to reject seed from a belt of a certain width round the edge of the plot. This method was devised by Balls, who in a recent bulletin (*Tech. and Sci. Serv. Bull.* No. 89, 1929, Govt. Press, Cairo) discusses the complications which beset experimental work on this subject. When Balls put forward the belting method he did so on the assumption that the bees which were assumed to be the principal agents in carrying pollen would on the average be more likely to contaminate the flowers near the margin of the field than those lying in the centre. It was assumed that by the time the bees got to the middle of the field, the foreign pollen would have become more or less filtered out. He provisionally adopted a ten-metre belt in a close planted field crop.

The results of observations of Balls and his co-workers may be summarised as follows:—

1. Thirteen different species of insects were caught within cotton flowers and are considered to be responsible for natural crossing.

2. The small wild Hymenoptera such as Nomia are shown to be more important than the honey bee as the agents of natural crossing. The idea of diffusion from the field inwards is substantiated except for the big Hymenoptera and these appear to be of the third order of importance. A gauze of 64 meshes to the square inch is fine enough to exclude the pollinating agents.

3. The existence of a large weekly variation in the amount of vicinism is attributable to the habits of the pollen carrying insects.

4. The maximum vicinism seems to be at least one per 1,000 at distances as great as 100 metres, when contamination is taking place from a line front.

5. The minimum area recommended for a propagation plot is ten feddans and a 100-metre belt round the small central portion should be rejected. Only the seed from the central portion can be retained with the likelihood of containing less than one vicinistic rogue per thousand.

It seems to the writer that if a pure line could be marked by some good recessive character the purity of a strain could be preserved with perhaps less trouble. The character white pollen, which is easily transferred to any Peruvian type, and which can be recognised in the bud state before flowering commences, would seem to be admirably adapted for this purpose. If a number of pure lines were grown, various combinations of recessives would be necessary, and one might suggest certain combinations of the factor pairs *R-r* (red-green leaf), *Y-y* (yellow flower-white flower), *P-p* (yellow pollen-white pollen), *S-s* (spot-spotless). Thus if a district growing an *R y p S* cotton were adjacent to one with an *r Y P s* type, rogues in the former could be recognised by their yellow corolla and pollen, while rogues in the latter would show red plant body and petal spot. The possibilities of maintaining purity by this method are very great.

The Editor is prepared to consider signed articles for publication in *Tropical Agriculture*. Such articles should normally vary between 1,000 to 6,000 words and may be illustrated if desired. Rates can be obtained on application to the Editor.

GUMMING DISEASE OF CANE.

[*The following information has been abstracted from a paper* (*Bulletin No.* 36, *which was read at the Third Conference of the International Society of Sugar-Cane Technologists*) *by D. S. North on the "bacterial-vascular diseases of sugar-cane."*]

GUMMING has been under close study for the past three years. By means of strictly controlled experiments it has been definitely shown that it is freely carried from leaf to leaf by wind blown rain, and by flies.

When the leaves are wet, the bacteria exude freely from the gumming streaks in the leaves, chiefly from wounds, a watery suspension thus being formed. This is splashed by the rain drops and carried by the wind to other leaves, which at the same time, become scratched, split, torn or bruised by being blown about and rubbed against each other. These fresh wounds afford a ready entrance for the bacteria. From those that are thus infected leaf streaks develop, becoming visible in about two to four weeks. Most of the streaks originate in minute wounds caused by the spines on the edge of one leaf scratching the upper surface of another leaf, these spines being peculiarly adapted for piercing vascular bundles sideways. Very rapid, intense, but strictly localised spreading, frequently results from wind blown rain in this manner. With a succession of severe rain storms, the leaves of every stalk in a crop may quickly become infected. Exuding of the bacteria may commence within a week after a leaf becomes infected, even before the leaf streak becomes visible, the sources of infection thus being rapidly multiplied.

Spreading by flies also occurs in wet weather. They merely act as mechanical carriers of the bacteria from leaf to leaf, the rest of the process being similar to that of spreading by wind blown rain. Although spreading by flies is comparatively rare, its great importance lies in the fact that they sometimes carry infection over long distances and thus establish new centres for further spreading by wind blown rain.

Several species of flies, including *Lucilia sericata, Calliphora augur, Sarcophaga sp.* and two other undetermined species have been proved capable of transmitting the disease in this manner and it is therefore considered likely that many other species of similar habits (blow flies, house flies, sour rot flies, &c.) may also do so.

Gumming is primarily a leaf disease. For long periods it may consist solely of leaf streaks, which, like many leaf spots, begin and end in the leaves.

But in dry weather the leaf streaks gradually disappear with the normal maturing and withering of the leaves, as no fresh infections are taking place, so that a crop may thus completely recover. However, the plant's resistance is often lowered by the dry weather check, sufficiently to allow some of the streaks to grow down through the leaf sheaths and into the stem, when systemic infection results, and the whole plant becomes clogged with the bacteria. On the return of wet weather they exude freely from the leaf sheaths and from parts of the stem, dissemination thus recommencing as before, and the disease thus surviving extinction during the dry weather.

The bacteria exude in the form of a slime, generally referred to as "gum." The functions of the gum are remarkable. Its sticky nature is such that the bacteria can only be separated and disseminated when dissolved into a watery suspension, so that dissemination is only possible under moist conditions. Drying, even when only partial, firmly fixes them to each other and to any substratum. The gum can only exude under moist conditions. On drying, it quickly blocks up all the exits from the plant, just as clotting of the blood stops bleeding. So that in dry weather the bacteria are stored in the plant, to await moist conditions, favourable for their dissemination. Dissemination does not occur in dry weather, except for a little, when there is heavy dew.

The gum also increases the resistance of the bacteria to sunlight, heat and drying. They are killed by ten minutes exposure to sunlight, when well separated in a Petri dish agar culture, by four to five days exposure to air-drying in a thin film on a cover glass, and by ten minutes heating at 49° to 50°C. in a fluid suspension. Whereas, as droplets of gum, they survived 32 hours exposure to direct sunlight (all the intense sunlight obtained in a week) on glass, and four and a half hours on a steel cane knife. A thermometer resting on the knife alongside registered 50°C. Droplets of gum on glass, also survived 12 weeks exposure to air drying, but were dead after 20 weeks.

Mixed with moist soil they all perished in four days, but mixed with well air dried soil they survived for a fortnight. Thus all the bacteria washed off the plants into the soil by the rain must perish within a few days. That infection from the soil can rarely, if ever, occur has also been strikingly indicated by a varied series of planting tests.

Dissemination by knife infection of cuttings will readily take place in dry, as well as wet weather, and by inter-row cultivation when the leaves are wet. However, dissemination by these means is preventable.

Dissemination by wind blown rain and by flies (natural agencies over which we have no control) is so rapid under New South Wales and southern Queensland conditions, that resistant varieties provide the only practicable means of control. But no immune varieties are known. No varieties sufficiently highly resistant to withstand repeated intense infection from a neighbouring crop of a susceptible variety are known. However, we have a number of varieties so highly resistant that they can be cropped without any damage, provided that no susceptible varieties be grown in the vicinity. In fact, it is clear that the disease can even be completely eradicated by cropping these resistant varieties and rigidly excluding all susceptible ones. Lightly infected crops frequently recover completely in periods of

drought when the leaf streaks disappear in the manner already indicated. The whole history of gumming bears this out.

The greatest obstacle to successful control in Australia is the system of small farm holdings, under which each grower must perforce plant ten acres or so per annum, a small area frequently surrounded by other infected crops. This applies with particular force where crops are harvested at two years old. In North Queensland dissemination is greatly restricted by all the crops being harvested at one year old, so that control can be more readily effected. And in places where the cane is cultivated in large blocks and harvested annually, control by rigid seed selection and other clean cultivation methods becomes practicable, even while cropping moderately susceptible varieties.

CITRUS FRUIT JUICES.*

A report issued by the Empire Marketing Board concerned mainly with non-alcoholic beverages prepared from citrus fruit juices has been received. The first section of this report deals generally with orange, lime, lemon, grapefruit and other fruit juices. The second and third sections with the manufacturing and retail trades, while in the fourth section the general position is briefly summarised as follows. There is a general consensus of opinion among manufacturers that a steady increase in the consumption of orange and lemon squashes may be expected. The consumption of lime juice is decreasing. Grapefruit juice has been introduced so recently that it is not possible to make any statement as to what is likely to happen.

In the United States, the Californian Fruit Growers' Exchange disposes of a large quantity of oranges and lemons by the use of "Sunkist" extractors. A few of these extractors are in use in London, but it is not possible to state what the development along this line is likely to be.

Raw juice extracted abroad forms the basis of most of the orange and lemon squashes and of all the lime juice sold in the United Kingdom. The most suitable time for delivery is during February and March, when fresh fruit is available from the citrus producing countries of the Northern Hemisphere. While juice can be preserved and stored for a considerable period, a certain amount of deterioration is liable to take place and fresh juice is normally preferred by the trade. From that point of view, countries in the Southern Hemisphere are at a disadvantage. The alternative of manufacturing for export a bottled squash containing a maximum amount of true fruit juice might be worth consideration, since the larger the percentage of true fruit juice, the less would be the proportional cost of the bottle and of the shipping charges. Such development should, however, be preceded by detailed investigation.

* Report on the Marketing of Citrus Fruit Juices in the United Kingdom, by A. J. Beyleveld, B.COM. (Stel.), PH.D. (Cornell).

SOMALILAND GUM INDUSTRY.

THE gum exported from Somaliland is known as Acacia gum. It is obtained from two kinds of trees, called by the Somalis "Adad" and "Jalefan." Other acacia gums are also collected which are, however, of much less value. The product of both trees has so far invariably been mixed together during collection, though more "Adad" than "Jalefan" gum was always collected owing to the trees being in much greater numbers.

Though gums of various sorts have been exported from Somaliland for hundreds of years, and though a fair proportion of the revenue has long been derived from them, beyond the fact that the trees are Acacias, nothing is known of them. From the industrial standpoint the most important gum on the European market is, at present, Acacia Verek. The demand for it is increasing year by year, and in countries in which the tree is known to occur in numbers, *e.g.*, the Sudan and Senegal, great effort has been made for many years to foster its cultivation, and to improve its quality as a marketable commodity. In Somaliland, licences are issued to natives for gum collecting, and export duty is charged on the gum, but it is not even yet known whether the material collected contains either in greater or smaller part the particular Acacia Verek.

The gum occurs as blebs or as a thick coating on the main stem of the trees close to the ground. After a time, the blebs may fall off on to the ground. The native collectors pull off the blebs and coatings from the stems, or pick up the fallen gum, careless whether bark or sand is still adhering. The pieces, whether of "Adad" or of "Jalefan," are put into baskets or sacks, and taken to the coast, though it must be said for the collectors that after the gum has been picked, it is not again allowed to touch the ground.

In the hills, no method of tapping the trees is employed. The gum is allowed to exude naturally, and is then pulled off, though, in some cases a wound is formed on the bark through the force exerted in taking off the bark. A rudimentary method of tapping is, in some instances, adopted, which takes the form of deliberately bruising the bark of the stem over a space of a few inches. Nevertheless, nowhere is any slitting of the bark practised, so that only very rarely does the gum come clearly from the stem.

At present the gum is bought from the producers by traders on the coast; it is then shipped across to Aden. On arrival there, it is, according to London merchants who handle the material, mixed with gum from India and Arabia, and sold in London as "Adad" gum.—(*African Industries*, Vol. XX, Nos. 25 and 26.)

PUBLICATIONS FOR SALE.

COPIES of *Experimental Error*, by Dr. E. J. Maskell, price 1S. can be purchased on application to the Editor, *Tropical Agriculture*.

TROPICAL WORLD NOTES.

Northern Rhodesia.

Of the whole territory of Northern Rhodesia, about six and a half per cent. is alienated land. Most of this is used for grazing, some of it is cultivated, while a large area is unsuitable either for grazing or cultivation owing to the absence of water. The total area under staple crops in 1927-28 was 53,333 acres distributed as follows :—

	acres.		*acres.*
Maize	..43,889	Wheat ..	1,819
Tobacco ..	7,339	Cotton ..	286

Minor food crops such as ground-nuts, potatoes, kaffir corn, &c., are also grown.

The highest yield of maize was recorded in 1927 when an average of 5.50 bags were grown to the acre. The tendency which has been prevalent to plant ever increasing acreages is being slowly displaced by a policy of reasonable acreages well planted and fertilized, a policy which should eventually result in an increase in yields. After satisfying all local requirements, the maize grown has supplied a considerable amount for export to the Belgian Congo. A large amount of the farm grown maize is handled by a co-operative society, which, in the past, has secured large contracts for the Congo mines, and it is hoped that similar contracts will be obtained in the future. Owing to the development in mining areas in the territory, the local demand for maize has increased very considerably and the general position is satisfactory. The average price of farm-grown maize, which must be regarded as the te ritory's staple crop, has been about 11*s.* 6*d.* per bag of 200 lb. net.

The variety of tobacco grown is a bright Virginia and until the year under review the industry appeared to be in a prosperous condition. Record crops, however, grown in 1927-28, both in Northern and Southern Rhodesia glutted the markets with the result that sales practically ceased and planters were placed in grave financial difficulties.

As regards cotton growing, experience has shown that the variety of seed used in the past has been unsuitable for local conditions but experimental work is being actively prosecuted to discover a suitable variety. Coffee planting is in an experimental stage, the prices, however, obtained in the United Kingdom have been most satisfactory. There appears to be no reason why coffee planting should not become of considerable importance. Citrus exports are increasing rapidly, a large proportion going to the Belgian Congo.

The crops grown by natives are at present mainly confined to foodstuffs for their own consumption, though in certain districts, especially in the proximity of the mines, additional quantities are grown for sale. Preliminary investigations have been made with a view to ascertaining whether other economic crops can be introduced to areas remote from the railway line and the mines to enable the natives to produce cash crops at their own villages. In the report of the Assistant Agriculturist stationed in the Abercorn district, there appears the following statement :—

"There is no doubt about the keenness of natives to take up agriculture, but at present they do not see any reason why they should change their methods of growing their foodstuffs because they are able to produce all the food they require."

It is very questionable whether the first portion of the statement can be applied to the natives of the territory in general, but there is no doubt that the latter part expresses most aptly the feelings of the majority. There are, of course, the few who are anxious to copy and benefit by the methods adopted by Europeans, and the number of ploughs which are sold year by year at up-country stores is indicative of the progressive feeling which is being engendered in the minds of those who live in the proximity of settled areas. In the more remote districts very little improvement has taken place.—(*Colonial Report for* 1928, No. 1470.)

* * *

Venezuela.

According to a Department of Overseas Trade Report by Mr. R. J. Kirwin dated November, 1929, Venezuela's wealth, apart from petroleum, which can hardly be called a native industry, is almost solely agricultural. The principal products are coffee, sugar, cattle, balata, fertilisers and tonka beans, the first two being the most important. Coffee is grown principally on the Andean heights in the States of Merida, Tachira and Trujillo, the crop being shipped through Maracaibo, and also in the mountains stretching to the east from Caracas, this crop being shipped from La Guaira and Puerto Cabello. About 43 million kilos were exported in 1927-28, the greater part going to Germany. Cocoa, which is grown in the coastal regions stretching from the borders of the State of Falcon as far as the Delta of the Orinoco, is exported to the extent of about 16 million kilos annually. The best customers are the United States, Spain and Germany, a smaller market being obtained in Great Britain and France. Sugar, which is grown in most parts of the country, is mostly consumed locally, the surplus, about five million kilos, going to the United States. There are large tracts of land eminently suited for cattle raising, but the lack of transport prevents this industry from obtaining the importance to which it is entitled. Owing to the impossibility of the beasts fulfilling the Government requirements as to condition after their long trek, lasting some weeks, from the pasture grounds to the slaughter houses the export trade in carcases has completely stopped. The export of hides, however, is still an important industry, skins to the value of about nine million bolivares* being exported annually. The trade in balata was at one time of considerable importance in the Ciudad Bolivar district, but has declined in recent years. About 400 tons are exported annually, Great Britain being the largest consumer.

* 25·25 Bs. = £1.

Gold Coast.

The total value of external trade in the Gold Coast declined in 1928-1929 by £2,095,977, a decrease attributable to normal fluctuations of trade. In spite of he fall in price of cacao, 15,167 tons were exported in excess of the quantity shipped in the previous year. Cacao, as the staple product of the Colony represented no less than 81 per cent. of the total export trade. The average *f.o.b.* values per ton in 1927 and 1928 were respectively £55.87 and £49.89. Figures of the percentage exports contributed by the three Provinces show that Central Province ports have improved at the expense of Accra, owing to the increase in the number and the improvement in the quality of the roads of the Central Province which now cross the River Pra and tap Southern Ashanti.

The following statement gives the destination of the cacao shipped in 1927 and 1928 :—

	1927. *Tons.*	1928. *Tons.*
United States of America ..	60,529	52,737
United Kingdom	48,288	51,214
Germany	44,040	54,330
Holland	38,953	43,042
France	7,287	9,095
Other countries	10,813	14,659
Total	209,910	225,077

* * *

Cyprus.

It is reported that the limes introduced from Sierra Leone by the Director of Agriculture are making vigorous growth and have every appearance of doing well and of being a useful introduction to the Island. As a commercial variety the *Trifoliata* orange has been found worthless, it is valuable as a stock on which to graft other varieties of citrus. These plants have been introduced as a stock for the Satsuma oranges now in the Nicosia Nursery Garden.

A plot of *Efwatakala* Grass has flowered. It was formerly introduced by the Director of Agriculture from Columbia (South America) for cultivation in West Africa, where it was since found to be indigenous. It is a valuable pasture grass for fattening cattle and is considered to be of value in the control of certain insect pests. A Lath House has been erected in the Nursery Garden. It is an idea introduced from California and will be of special use in Cyprus in the spring and heat of summer for raising and growing young plants to protect them from the intense heat. The house is constructed of laths and allows sufficient sun to penetrate without scorching the seedlings In a structure like this the plants are never in dense shade as is often the case when the plants are placed under shade trees or mattings.—(*Cyprus Agricultural Journal,* Vol. XXIV, Pt. 4.)

Togoland .

The work of the Department of Agriculture in the southern section of Togoland under British Mandate during the year 1927 was very severely handicapped by a serious outbreak of yellow fever amongst members of the staff. The principal agricultural products are cocoa, cotton and palm oil. The area under cocoa continues to increase and many new plantations have been started. No appreciable increase is shown in the 1927 export figures, but this was accounted for by the lateness of the 1927-28 crop of which only a small proportion could be exported. The previous year's scheme for the distribution of cotton seed had to be abandoned on account of yellow fever. The amount of cotton exported to French Togoland, however, showed only a very small decrease which was attributed to seasonal variation. An important industry is the cultivation in the Kpando District of food crops (particularly of yams and corn) which are marketed in Accra and other large centres of population in the Colony. — *Colonial Report* No. 36.

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Sudan.

In the *Sudan Notes and Records,* Vol. XII, Part I, Mr. G. O. Whitehead publishes a study of the social organisation of the Bari, with special reference to the changes which have taken place comparatively recently in the status of the various social groups. The Bari were formerly composed of freemen, *Lui*, and servile groups, collectively called *Dupi*. The *Dupi* proper were serfs who cooked, and were of a physique markedly distinct from their masters. They did not own cattle, but are supposed to have lost them to the freemen. Yet they had to pay cattle on marriage, these being obtained from their masters. For this the masters had a claim on their services. Probably they were racially distinct from the freemen who had conquered them when they invaded the land. Other classes were the hunters, neither owning cattle nor cultivating land. They paid tribute to their chief. Two other classes were the Artisans of the Forge and the Artisans of the River, each living in separate villages. They were not so servile as the *Dupi*. They had few or no cattle, yet married independently of their chief's assistance owing to the value of the goods they produced. The introduction of money, the increase in agriculture, and disturbance due to unrest in the Sudan have brought about a redistribution in the ownership of cattle, which no longer belong exclusively to the *Lui*, and a dislocation of the pastoral life. This has blurred the hard-and-fast lines between the classes. The *Dupi* no longer depend on the *Lui* for their marriage arrangements, while under European control the position of the chief is changed and depends upon the relation with the Government rather than his own intrinsic position. The advice of the fathers of the soil is no longer listened to as it once was.—(*Nature,* Vol. CXXV, No. 3140.)

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

The Utilisation of Waste Products.

The Chemical and Technical Research Unit of the American Bureau of Chemistry and Soils is studying methods for the utilisation of waste vegetable products. Such products may be placed in four groups, namely ; starch containing materials, vegetables and fruits, sugar-cane bagasse, corn stalks.

Starch Containing Materials.

Large quantities of sweet potatoes which fail to satisfy the grading requirements of the American market are wasted annually. It is suggested that they could be used as a source of the starch required for the manufacture of dextrins and adhesives. The starch content of sweet potatoes is high and comparatively easy to separate. As a preliminary step, therefore, the physical and chemical properties of the separated starch are being studied in order to determine its suitability for these purposes. It is suggested that the factories necessary for the extraction of such starch might be used out of season and during years of low sweet potato crops for the extraction of starch from materials such as surplus white potatoes and injured rice. The overhead expenses of the factories would thereby be reduced. Economic factors such as the necessity for cheap transport and the maintenance of a regular supply of raw material would probably present the chief difficulties to be overcome before such a factory could be run satisfactorily.

If the separation process is successful and the product satisfactory, it might be profitable in tropical countries to grow sweet potatoes solely for their content of starch.

Fermentation of the separated starch or of the raw material by controlled enzyme action to form alcohols and organic acids suggests itself as a further method of utilising these important wasted crops.

Vegetables and Fruits.

The problem of the rapid utilisation of surplus perishable goods unsuitable for tinning is important in all fruit and vegetable growing countries. The growers of citrus fruits have solved the problem for their own products. Large quantities of pure pectin are being produced from citrus fruits which formerly were wasted, the residue being used as cattle and chicken food.

The production of essential oils from waste fruits is being investigated. The preparation of preserved fruit juices would provide a valuable method of storing the properties of the fruits once a sufficient public demand could be created. Investigation of the methods of extraction and preservation of fruit juices is therefore to be undertaken.

Sugar-Cane Bagasse.

The Bureau recognises that the prosperity of the sugar-cane industry depends very largely upon ability to utilise waste products. The possibilities of the use of sugar-cane bagasse in paper and board making and road making are being investigated. It is suggested that it could be used for the production of mixed feeds, artificial silks, bagasse flour as an absorbent, an insulating material, the production of chemicals by dry distillation, and the recovery of cane wax. Most of these applications, however, require extensive investigation before they could be used commercially.

Cornstalks.

The destruction of cornstalks is advisable for the control of corn borer. Added incentive is thus given to their utilisation. The main pro pects are in the manufacture of insulating material and artificial board. It is hoped that briquet fuel and organic fertilisers may also be obtained. Their value as feeding stuff will be investigated.—(*Ind. Eng. Chem. News Ed.*, Vol. VIII, No. 4.)

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The Action of Farmyard Manure.

Farmyard manure when added to the soil produces a great increase in the biological activity in that soil. It is stated (C. Barthel, Z. Pflanz. Düng., 1929, S.B. 557) that this increase in activity is due, not to the addition of large numbers of micro-organisms, but to the stimulation of organisms already present in the soil by the added nutrient. Ammoniacal and amide nitrogen are the chief active nutrients. Nitrogen combined in more complex organic compounds is not available for the organisms and may remain so for more than twelve months.—(*Brit. Chem. Abs.*, Vol. XLIX, p. 73.)

* * *

Chemical Studies on Sugar-Cane.

The effect of applying varying amounts of nitrogen, phosphate and potash fertilizers to sugar cane has been studied at the Porto Rico Insular Experiment Station (Annual Report, 1927). A total of 280 plots was used. Very little change in the composition of the juice resulting from any fertilizer treatment was obtained. The highest increase in yield was given by plots receiving phosphatic fertilizer alone. The next highest increase was given by plots receiving all three elements. In general, the plots receiving nitrogen gave the lowest yields.

Cane sampling experiments for juice analysis showed that identical results were obtained from 100 lb. samples and from 800 lb. samples. A comparison of the juices obtained from laboratory mills and factory mills showed the latter juice to be of higher purity.—(*Chem. Abs.*, Vol. XXIV, p. 520.)

Feeding Material from Wood.

The disposal of wood-waste not required for fuel constitutes a serious problem in the timber industry. German chemists claim to have solved the problem by converting the wood into a feeding stuff. By the controlled action of concentrated hydrochloric acid, the cellulose of the wood is hydrolysed to sugar and a feeding material obtained to the extent of two-thirds the weight of the original wood. The residual lignin is converted into fuel briquets. Acetic acid is also obtained as a by-product. Feeding trials have shown the material to have satisfactory nutrient value, particularly for pigs. It is suggested that the feed be improved by the addition of potato flakes. Although it is claimed that this carbohydrate feeding stuff can be produced more cheaply than grain feed, it seems improbable that markets other than those of the central European countries will be affected.

The results of the application of a similar process to sugar-cane bagasse with its high content of cellulose would be interesting.—(*Ind. Eng. Chem. News Ed.*, Vol. VIII, No. 5.)

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Vitamin Content of Pigeon Peas.

The great value of pigeon peas as a feeding stuff for cattle has led to determinations of their vitamin content. In the determinations the usual method of feeding rats with vitamin free diet was adopted. Both the plant meal and the seed meal were tested. The plant meal, consisting of the entire dried plant, was found to be a good source of vitamin A whereas the seed meal had only a low content. Both plant meal and seed meal have high contents of vitamin B. It is suggested that since yellowing colouring matter and vitamin A are often associated in plant foods, development of a variety of pigeon pea with a yellow seed might lead to one containing more vitamin A.—(*Journ. Agri. Sci.* 18, 569.)

FEEDING VALUE OF RICE.

Dr. McCarrison has brought forward evidence in the *Indian Journal of Medical Research* that some difference in the nutritive value of crops—quite apart from yield—may be observed according to the conditions of water supply of the crops while growing. For rice he states :—

(1) The nutritive value of rice is influenced by the conditions of water supply under which the crop is grown ;

(2) Rice grown on puddled fields in which a layer of water is always allowed to remain has a nutritive value approximately one-third less than the same rice when grown under dry rain-fed conditions ;

(3) The lower nutritive value of rice grown under wet conditions is due, in part at least, to its lower content of vitamins of the water-soluble-B class ; and

(4) It seems probable that the conditions of cultivation of rice, especially in regard to water supply during the growth of the crop, is a factor of importance in determining the endemicity of beri-beri.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Vacuum Pans at Honolulu Plantation.

Four new pans installed at this factory are interesting from the standpoints of design and heat economy. The calandrias of the commercial sugar and low grade pans have copper bearing steel flat tube sheets, the calandria section being welded throughout, thus eliminating the possibility of the leaks at the joints between tube sheets and centre well. The tube sheets of the white sugar pan are of bronze. The centre well is extended for a considerable distance below the lower tube sheet, thus ensuring active circulation in the lower cone. There has been no difficulty in making a finished sugar of satisfactory grain, well above the usual standard of "25 per cent. total small grain." The volume of massecuite to the top of the calandria, or the so-called "graining volume," is 37 per cent. of the working capacity for the 12-ft. pans and 29 per cent. for the low grade pan. The heating surface of the 12-ft. pans consists of 648 four-inch outside diameter tubes, giving a total surface of 2,276 square feet. The volumetric capacity of these pans is 1,200 cubic feet, measured to four inches below the top of the main belt. This gives a ratio of 1.9 square feet of h. s. per cubic foot of working capacity. The low grade pan is 13 feet in diameter, and has a h. s. of 2,662 square feet, with a working capacity of 1,800 cubic feet, giving a ratio of 1.48 to 1.0. The calandrias are of the baffled type, with a single inlet for steam. The baffles produce a positive flow of steam throughout the calandria, and also provide a definite point for the evacuation of non-condensible gases. The two air vents are connected to a common pipe, which discharges to the vapour space ; a thermometer is installed between the air vent connection and the control valve, and from the temperature indicated it is possible to measure the effectiveness of the venting. For example, with a pressure of 3 lb. on the calandria, corresponding to a temperature of 220°, the thermometer would register 220° if the air vents were discharging vapour without any measurable quantity of collected gases. The commercial sugar pans and the low grade pans operate entirely on vapour from a special pre-evaporator. With the exhaust steam pressure at 6 to 8 lb., the vapour pressure available for the pans is from 3 to 5 lb., which is ample for all requirements. At this pressure it is possible to start a pan and boil a full strike of grain in four hours or less ; after a cut, a pan may be finished, and boiled to proper density for purging in about four hours with a maximum pressure of 4 lb. The average vapour consumption for all pans, based on performance over a 24-hour period, is from 30,000 to 35,000 lb. per hour. This represents a reduction in evaporation at the quadruple effect of an equal amount, and since this is only single effect evaporation,

it is equivalent to a saving of from 7,500 to 8,750 lb. of exhaust steam which would be required to evaporate the same quantity of water at the evaporators proper, representing a saving of from 1.5 to 2 barrels of oil per hour. With the large heating surfaces available, it follows that the actual evaporation per square foot of heating surface will be lower than is the case when higher steam pressures are used. For the commercial sugar and low grade pans the duty is approximately 5 lb. of evaporation per square foot per hour. The white sugar pan usually operates on exhaust steam, though during the early stages of the strike it is possible to use vapour for concentration of the initial charge. Steam flow measurements show that with a pressure of 10 lb. on the calandria of the white sugar pan the steam consumption may go to 25,000 lb. per hour, which is equal to 12 lb. per square foot per hour. With both commercial sugar and low grade pans there is no difficulty in securing a very satisfactory grain, free from any more than the usual amount of "conglomerate;" at 4 lb. pressure the pans may be boiled to a satisfactory density and during the earlier stages a pressure of 1 to 2 lb. will give a very vigorous circulation. There is absolutely no difficulty from massecuite lodging on the tube sheet, even when the strike is boiled to high density.—(*The International Sugar Journal*, Vol. XXXII, No. 374.)

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Investigations on Cane Molasses Distillery Slop.

E. K. Nelson and C. A. Greenleaf, *Industrial and Engineering Chemistry*, Vol. XXI, pp.857-859.

THE disposal of distillery slop resulting from the manufacture of molasses from cane sugar is a considerable problem. The best that can be done is to concentrate it to the point where it will burn; ammonia is recovered from the combustion gases and potassium salts from the ash. The authors have made a somewhat extended study of the composition of the slop.

Considerable quantities of formic, acetic, succinic, tricarballylic, and lactic acids, a small quantity of aconitic acid, and a possible trace of citric acid were found. Examination of a sample of the molasses from which this slop was derived revealed no succinic and tricarballylic acids and only a little lactic acid.

The succinic acid and most of the lactic acid are evidently products of the fermentation. The disappearance of the greater part of the aconitic acid and its replacement by tricarballylic acid leads to the conclusion that, in the process of fermentation, the aconitic acid has been reduced to tricarballylic acid.

Glycerol was identified, but the quantity was not large enough to make its extraction appear profitable.—(*Facts About Sugar*, 24. No. 38, 898.)

White Sugar Manufacturing.

The undesirable dark or greyish tints often shown by white sugars are attributed to traces of iron compounds. Scheller found that tannins and polyphenols present form dark compounds with iron, and concluded that traces of iron are sufficient for producing a dark colour in juices containing polyphenols; that reducing agents such as SO_2 and hydrosulphites cause only a temporary bleaching, the colour returning on oxidation; that the dark tinge of plantation whites, which increases during storage, is due to traces of phenol iron compounds; and that the only practical means of prevention are: the reduction of ferric to nearly colourless ferrous compounds by means of proper reducing agents; and the decomposition of the phenol iron compounds by acidification. That these salts in the ferrous state, show no effect on the colour is recognised and the need of an acid or reducing medium is emphasized by several authors. Writing on this subject L. Pitot (*Revue Agricole* of Mauritius, 1929, No. 46) recommends maintaining the acid medium in the liquors going to the pans (using Blankit at the moment of graining if sulphitation of syrups and thick juices is not possible); avoiding the air in the mixers, by rejecting open crystallizers and using closed ones under vacuum; and the addition of sulphurous water to the massecuite. To 26 tons of massecuite, dropped at 97 Brix, he adds some 1,100 litres of sulphurous water, thus decreasing the Brix to a point suitable for centrifugal work, and assuring an acidity of 0.500 grams per litre of the syrups of the massecuite. Lining iron surfaces with rust proof enamel is important; also avoiding white cane tops, as these are rich in tannins and polyphenols.—(*Sugar*, Vol. XXXI, No. 12.)

RUBBER IN FLORIDA.

PARA rubber trees planted by the Department of Agriculture in Florida are making encouraging progress, according to a report recently given to the Appropriations Committee of the House by Dr. Karl F. Kellerman, associate chief of the Bureau of Plant Industry. The oldest trees in the experiment are four years old. The department has discovered that young rubber trees in such a climate as Florida's must be protected by lattice work. The trees will grow about as well as they do in Haiti, Dr. Kellerman believes. The growth in Haiti is satisfactory, inasmuch as the trees produce as much rubber as they do when grown in the tropics, though they do not seem to be quite so vigorous. A new type of rubber plant from Madagascar is being grown in the department greenhouses and in the Southwest, Dr. Kellerman says. This rubber is known as *Euphorbia intisy*. Growing in its wild state, it formerly produced a superior rubber of the Para type, for which purchasers would pay three or four times as much as they would give for any other rubber.—(*Science*, Vol. LXX, No. 1825.)

ENTOMOLOGICAL NOTES.

Compiled by the College Department of Entomology.

Natural Enemies of *Diatraea saccharalis* in Cuba (1).

The three papers mentioned below issue from the Cuba Sugar Club Experiment Station and give a complete list to date of the natural controls of the small moth-borer of sugar-cane recognised in Cuba. Of these, certain parasitic insects appear to be the most important and their biology is discussed in some detail. Lists of Nematode worms and fungi known to attack the borer are also furnished.

Of the insect enemies of *Diatraea*, some eighteen species of parasites and predators are mentioned; four of these are of major importance and together, they may parasitize half the borers present under the most favourable conditions.

The most abundant parasite seems to be the Tachinid fly, *Lixophaga diatraeae* Townsend, which is well distributed over the greater part of the island throughout the year. The percentage parasitism of borer larvae by this insect is very variable, apparently depending upon rainfall. There are few natural enemies and the insect appears to be eminently suitable for shipment to other countries.

The chief artificial restriction of the parasite is the practice of trash burning. The custom of cutting out "dead hearts" is also condemned.

Other important parasites of borer larvae are the Braconids, *Apanteles diatraeae* and *Bassus stigmaterus*. The latter is of particular interest since it comes to the fore during the summer months when the other parasites are at a minimum.

The egg parasite *Trichogramma minuta* Riley is shown to be very irregular in geographical and seasonal distribution and the habit of this parasite of attacking only a few eggs in the cluster militates seriously against its efficiency as an economic control.

The nematodes and fungi listed do not appear to be of practical importance at the present time.

* * *

Pink Bollworm in Australia (2).

The nomenclature of the Pink Bollworms of Australia has been in a state of considerable confusion and it seems that four species have been included under the name *Platyedra gossypiella*. Holdaway has established that there are two distinct Pink Bollworms which attack cotton in Australia, *viz.*: *Pectinophora gossypiella* and *P. scutigera* (referring both species to the genus *Pectinophora* instead of to *Platyedra*).

Earlier suggestions have mentioned both East Africa and India as the ancestral home and centre of distribution of the genus; there seems to be equally strong evidence that the genus is also indigenous in Australia! Holdaway attempts to dissipate the seeming paradox by accepting Wegener's theory of floating continents, suggesting that the genus was established at a period when Africa, India and Australasia formed parts of the same continuous land mass, hat is, between the Carboniferous and Eocene periods.

This explanation is not without serious difficulties and perhaps cannot be accepted as it stands. It is, however, extremely suggestive in elucidating a difficult and most important distributional problem.

A. P.

(1) (*a*) Plank, H. K.—Natural Enemies of the Sugar-cane Moth Stalkborer in Cuba. *Ann. Ent. Soc.*, America, XXII, No. 4, Dec., 1929.

(*b*) Plank, H. K.—Nematodes Parasitic on *Diatraea saccharalis* Fabricius in Cuba. *Journ. Econ. Ent.*, 22, No. 6., Dec., 1929.

(*c*) Plank, H. K.—Fungi attacking *Diatraea saccharalis* Fabricius in Cuba. *Journ. Econ. Ent.*, 22, No. 6, Dec., 1929.

(2) (*a*) Holdaway, F. G.—The Pink Bollworm Situation in Australia. *Int. Congr. Ent.*, August, 1928, Vol. II.

(*b*) Holdaway, F. G.—Confirmatory Evidence of the Validity of the Species *Pectinophora scutigera* Holdaway (Queensland Pink Bollworm), from a Study of the Genitalia. *Bull. Ent. Res.*, XX, Part 2, August, 1929.

A COFFEE-BEAN DISEASE.

By G. B. Wallace, B.Sc., Ph.D.
Mycologist, Tanganyika Territory.

An injury in green and red coffee cherries in which the beans alone suffer, has been known to planters in Tanganyika Territory for some time. It is credited in literature to the Coffee bug, *Antestia lineaticollis* St.

The writer finds a fungus of the nature of Nematospora* invariably present, and is accumulating evidence that Antestia is the spreader. Plantations on Kilimanjaro and the Usambara Mountains are affected. The believed stigmatomycosis is very destructive, up to ninety-five per cent. of beans in ripe cherries being destroyed. The disease is to be distinguished from the "Coffee berry Disease" due to *Colletotrichum coffeanum* Noack, and described by MacDonald from Kenya.

Observations on the disease are being continued, and experimental work is in hand. Meantime the known methods used in the control of the bug are being stressed as evidently they are of greater importance than had been realised. When the investigation has developed sufficiently, a further statement will be communicated.

* Ashby, S. F. and Nowell, W. The fungi of stigmatomycosis. *Ann. of Botany*, XL. pp. 69-83, 1926.

REVIEWS.

The Health Game.

By B. E. Washburn, M.A., M.D. with 20 illustrations. *Messrs. J. and A. Churchill, London,* 1930.

Dr. Washburn has been for many years Field Director of the work of the International Health Division of the Rockefeller Foundation in Jamaica, where he organised a Hookworm Campaign, but realising the great need for improving the welfare of the people, he extended his activities into wider channels.

A Bureau of Health Education was started and by means of lectures and writings Dr. Washburn has done much to teach the people to help themselves along the path to freedom from disease. All this work has enabled him to augment his sympathetic understanding of the mental attitude of the West Indian to matters of health. This has borne fruit in the production of an educative health manual which is written in a simple but humorous and interesting colloquial style, and covers the whole field of the science of correct living, care of the body, general and tropical infectious diseases, their cause and prevention, public health generally and first aid.

The book fills a great need as a simple health educator for schools and the general public, not only for the West Indies but also for other countries. Hygiene teaching of the standard that this book contains would be a great economic investment for the community as well as the individual, for not only would it relieve a great amount of the detail work that burdens Public Health Departments but it would also reflect to advantage in the case of employers and State Institutions by reducing physical inefficiency and actual sickness.

E. A. S.

* * *

Coffee Growing with special reference to East Africa.

By J. H. McDonald. Published by *East Africa,* 91, Great Titchfield Street, London, W.1.

This book as the name implies, is a treatise on coffee growing with special application to East Africa but nevertheless contains information of value and of interest to coffee planters in other parts of the world.

The introduction of the coffee plant into many of the East African Colonies is a comparatively recent matter and the expansion of the industry to its present large proportions has been remarkably rapid. The advent of Mr. McDonald's book therefore is opportune since it is a work containing much valuable information collected from the long experience of coffee growers in other and older countries. His chapter on the culture of the crop includes a lot of practical common sense, which, if it were always applied to the cultivation of soil in the tropics would lessen the number of failures among those who attempt to make their living by planting. He points out that some people still wrongly believe that tropical soils frequently possess inherent virtues that are absent in soils of temperate climes and will grow crops for an indefinite time without soil renovation. Those who have had the opportunity of studying agriculture in both tropical and temperate regions have probably arrived at the conclusion that the problem of keeping up the fertility of the soil is the more difficult in the tropics.

The book is well illustrated and contains useful information on fungoid diseases and insect pests, and the methods of cultivation. The author has evidently gone to a great deal of trouble in order to obtain the best possible opinion.

As a text book and work of reference it should be equally useful either to the student of tropical agriculture who may be concerned with this crop or to the practical planter.

G. E.

BOOKS RECEIVED.

We have to acknowledge the receipt of the following books :—

AGRICULTURE.

Heredity in Livestock. C. Wriedt. *MacMillan & Co., Ltd.,* pp. XII, 180. Figs. 70. 7*s.* 6*d.*

MYCOLOGY.

Fungous Diseases of Plants. J. Eriksson. *Bailliere Tindall & Cox,* pp. VII, 526. Figs. 399, 35*s.*

HYGIENE.

The Health Game. B. E. Washburn. *J. & A. Churchill,* pp. XII, 202. Figs. 20. 5*s.*

EXAMINATION RESULTS.

The following students have been awarded the Associateship of the Imperial College of Tropical Agriculture :—

Mr. R. H. Fraser, B.Sc. Agric. (Edin.).
Mr. R. M. Maynard, B.Sc. (Birm.).
Mr. H. Hutchinson, B.Sc. (Durham).

COLONIAL APPOINTMENTS.

The following appointments and transfers have been made during the month of February, 1930, by the Secretary of State for the Colonies :—

Mr. W. Youngman, M.Sc., Ph.D., Director of Agriculture, Ceylon.

Mr. F. Burnett (Divisional Agricultural Officer, Ceylon), Deputy Director of Agriculture, British Guiana.

Mr. G. H. Donald (Assistant Conservator of Forests, British Honduras), Assistant Conservator of Forests, Kenya.

Mr. J. T. Kennedy (Assistant Live Stock Officer, Veterinary Department, Uganda), Senior Assistant Live Stock Officer, Veterinary Department, Uganda.

Dr. F. J. Martin (Agricultural Chemist, Sierra Leone), Assistant Director of Agriculture, Sierra Leone.

Mr. E. J. Wortley, O.B.E., F.C.S. (Director of Agriculture, Nyasaland), Director of Agriculture, Trinidad.

COLLEGE NEWS.

Dr. J. G. Myers sailed for the Northern Islands by s.s. *Lady Drake* on 26th March.

* * *

Sir Claud Hollis, K.C.M.G., the new Governor of Trinidad and Tobago, accompanied by Lady Hollis, visited the College on 1st April, and was conducted round by the Principal.

* * *

Mr. G. A. Jones, Assistant Commissioner of Agriculture for the West Indies, left in s.s. *Nerissa* on 19th March on a tour of the Leeward Islands and St. Lucia. He is expected to return to Trinidad on 11th May.

* * *

Mr. F. Hardy, Professor of Chemistry and Soil Science, sailed by s.s. *Inanda* on 13th April for British Guiana, where he has been asked to advise on certain matters connected with the soil investigational programmes of the Colony.

* * *

Mr. C. Y. Shephard, Professor of Economics, has been requested by His Excellency the Governor of Barbados to visit that Colony with a view to advising the local Department of Agriculture on the best means of instituting a system of co-operative credit societies amongst the peasants. Professor Shephard sailed for Barbados by s.s. *Vandyck* on 21st April.

* * *

It is satisfactory to note that the Legislative Council, at their meeting on 4th April agreed that the Government of Trinidad should contribute a sum of £8,500 a year for the next five years to the funds of the College. This system of block grants is to be commended and it is hoped will be adopted by other regular contributors, as it gives the College authorities an opportunity of preparing satisfactory estimates.

* * *

We regret to learn the death of Mr. J. W. Arbuckle, Attorney of Caroni Estates, Ltd., which occurred on 7th April. Mr. Arbuckle was one of the best known sugar planters in the West Indies. As a member of the Froghopper Investigation Committee he had been closely associated with the College Staff, and the estates under his charge have always been anxious to collaborate with the scientific workers at the College.

* * *

The Hons. L. A. P. O'Reilly, K.C., E.M. Hosein, Fred. G. Grant, A. A. Cipriani and Gaston Johnston, K.C., members of the Trinidad Legislative Council, visited the College on 8th April. They were shown over the College Sugar Factory by Mr. J. G. Davies, the Assistant Sugar Technologist, and Mr. C. T. Watts, the College Engineer, and were particularly interested in the training of sugar students. They also inspected the Low Temperature Station and the College Farm.

Amongst recent visitors to the College were Commander G. Curteis, R.N., H.M.S. *Wistaria*; Ellen, Lady Black, Reading, Berks.; L. V. C. Schwaiga, Agricultural and General Engineer, London; Dr. J. A. Forrest, Canada; and Mr. A. B. Menken, the official photographer to the Orinoco expedition; Mr. Frank H. Houlder, who was accompanied by his niece, Miss Burn. Mr. Houlder is the Chairman of Directors of the Houlder Shipping Lines, and is also a Director of Furness Withy Co. He was returning from a visit to his estates in the Argentine and Uruguay.

AGRICULTURAL EXCURSIONS.

The final excursion of the Lent Term was made on Wednesday, 19th March, when a large party of senior students and members of the Staff visited the estates of the Usine Ste. Madeleine Co.

A visit was first paid to Cedar Hill and Tarouba Estates, where hot weather ploughing has been undertaken. In this hilly Naparima country the use of steam ploughing tackle of the Fowler type, is not practicable, and tractor hauled implements are used. Students who had visited the flat Caroni estates in the previous week had thus an admirable opportunity of comparing the two methods. The usual type of tractor in use is the Caterpillar (Holtz) but a Diesel engined tractor by McLaren is now being tested out and was seen in action on some heavy land. Cultivation methods including the system of field drains, formation of beds for planting and other matters were thoroughly discussed, and a visit was made to several of the larger pens in order to view the estates' cattle herds. Particular interest was centered on the buffalo herds.

In the East, the domestic buffalo is used for two purposes. The Milch buffalo is regarded as the most important dairy animal and the male stock are considered of poor value and are usually worked hard at preparing paddy fields. In Trinidad the buffalo is beginning to be regarded as a useful draught animal for hauling carts—its value as a dairy animal is hardly suspected but its possibility as a potential supply of meat is being investigated. Under the circumstances it was interesting to note the presence of several specimens of the Marah or Delhi type which is the best milking breed in India.

The College party was hospitably entertained by Mr. G. B. Westwood, the General Manager, and Mrs. Westwood to lunch, when the Principal took the opportunity of pointing out the close association that has always existed between the two Institutions in matters concerning the advancement of tropical agriculture—a reciprocal statement was made by Mr. Westwood, and Mr. J. L. Scott gave utterance to a felicitous speech when expressing thanks to the ladies.

Visits to the Company's Dairy and to the Sugar Factory concluded a full day.

G. E.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows (c.i.f. per cwt.) :—

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
7th March ..	7	3	11	0
13th do. ..	7	3	11	0
20th do. ..	7	3	11	0
27th do. ..	7	6	11	0
31st do. ..	7	7½	11	4½
3rd April ..	7	6¾	11	6¾
10th do. ..	7	6	11	4½

Prices for the greater part of March have kept about steady, the Home Market remaining quiet. The Cuban situation was affected by rumours on the possible disbandment of the Single Selling Agency. An announcement was made by the Colonial Office on 14th March that the British Government would be prepared to give financial aid in connection with crop advances to sugar growers in the British West Indies, British Guiana and Mauritius. Under this scheme the British Government suggested that the Colonial Governments should guarantee the Bank or the approved lender one half of the losses of capital and interest on crop advances not recovered within 12 months from the end of the crop season, the liability to the Governments not to exceed 15 per cent. of the total advances made. These proposals have been regarded as being of insufficient assistance to the Colonies concerned.

* * *

COTTON.—The following are the official Spot Prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	*Egyptian F. G. F. Sakel.*	*Sea Island.*		
			Good.	*Extra fine.*	*Prices paid this Week.*
21st Feb.	8·47	13·50	24·50	38·00	27·00-32·00
28th Feb.	8·49	13·55	24·50	38·00	20·50-33·00
7th Mar.	8·18	13·60	24·50	38·00	24·00-33·00
14th Mar.	8·05	13·60	24·50	38·00	—
21st Mar.	8·54	13·90	24·50	38·00	23·00-23·50
10th Apr.	8·77	—	24·50	38·00	—
(local)	·	·	—	—	—

After a decline in prices in the first fortnight of March a much better turn obtained in the third week, a good recovery taking place in prices for American futures. Sea Island has been in limited demand without change in quotations.

COCOA.—The Market continues in a depressed state, and in the absence of demand, prices are only nominal. Production figures are not greater than last year so that statistically the commodity is sound.

* * *

TEA AND COFFEE.—Jamaica has been selling well at 200*s.* per cwt., Kenya at 80*s.* to 138*s.*, Brazil at 65*s.* Latest weekly tea averages have been: Ceylon, 20.77*d.*; India, 16.21*d.*; Java, 10.53*d.*; Chinese, 26.00*d.* to 36.00*d.* The demand in London has been good.—(*Times and Trade Engineering Supplement*, 22nd March.)

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows: 26th February, 8⅛*d.*; 5th March, 7$\frac{9}{16}$*d.*; 12th March, 7$\frac{7}{16}$*d.*; 19th March, 7$\frac{7}{16}$*d.*; 26th March, 7$\frac{9}{16}$*d.*; 3rd April, 7⅝*d.*; 9th April, 7$\frac{7}{16}$*d.* According to *Messrs. Symington & Sinclair*, speculative buying was stimulated at the end of February by the Anglo-Dutch proposals that tapping should cease during the month of May. These proposals have, however, failed to impress the chief buyers. The statistical position remains unfavourable to any rise, and prices have remained dull in consequence.

* * *

BANANAS.—Jamaicas continue in fair demand and are unchanged at £22 10*s.* per ton delivered or £22 per ton delivered nearest railway station, to wholesalers, and 10*d.* to 1*s.* per dozen (carriage extra) to retailers. Brazilians are also in fair demand at £20 per ton nearest station.—(*West India Committee Circular*, 20th March.)

* * *

LIME PRODUCTS.—*Lime Oil.*—Further small sales of Handpressed have been made at 50*s.* ex wharf. Distilled is neglected but nominally unchanged. *Lime Juice.*—Concentrated is again easier with sellers at £17 but buyers are holding it off. Raw is quiet and inactive.—(*West India Committee Circular*, 20th March.)

RUBBER IN 1929.

ACCORDING to Messrs. Symington and Sinclair's Annual Review the rubber market again experienced a very trying time in 1929. Although the heavy accumulations in Malaya and Ceylon were being absorbed and world consumption increasing rapidly in the first half of the year, in the second half, Malaya shipments rose steadily and American consumption dwindled; the resulting depression being helped by the Hatry affair and the collapse of the stock markets in New York. All forecasts of production and consumption figures for the year were grossly underestimated, there being a particularly heavy underestimate of consumption for countries outside the U.S.A. Spot prices for Ribbed, Smoked Sheet fluctuated between 1*s.* 1⅜*d.*, highest, in February and 7¾*d.*, lowest, in December; the year's average being 10¼*d.* Total production for 1930 is estimated at 846,000 tons and total consumption at 856,000 tons.

G. G.